EMPHATIC ASSIMILATION IN CLASSICAL AND MODERN STANDARD ARABIC

AN EXPERIMENTAL APPROACH TO QUR'ANIC RECITATION

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DECLARATION

I declare that this work has been written by me and that no one else has participated in the preparation of its contents.

Ayman A. H. Habis

TABLE OF CONTENTS

CHAPTER THREE
LITERATURE REVIEW ON EMPHASIS IN ARABIC

LIST OF FIGURES

LIST OF TABLES

LIST OF PHONETIC AND TRANSLITERATION SYMBOLS

The symbols listed below follow the standard IPA Chart, published in *Journal of the International Phonetic Association,* with the exception of those for emphatic coronals for reasons that are thoroughly explained in Chapter Three. In illustrative examples of recitation rules we will be using phonetic transcription. Ordinary transliteration will be reserved for other usages such as the citation of authors' names. The abbreviation 'E' refers to 'emphatic'. For information on whether a given sound is voiced or voiceless see Appendix II (Classical Features). The Arabic words *tajwīd* and *Qur'ān* will appear in the text in *italics* but the macron '¯' will not be used over the vowel symbols for simplicity.

No	Label	Phonetic Symbol	Transliteration Symbol	Other symbols used in the text/Comments
1	Glottal stop	ʔ	'	Classified as pharyngeal in *tajwid.*
2	Bilabial stop	b	b	
3	Apico-alveoloar stop	t	t	
4	Interdental fricative	θ	th	
5	Palatal affricate	dʒ		It may be also described as a stop.
6	Pharyngeal fricative	ħ	ḥ	ɦ (see Chapter Two).
7	Uvular fricative	χ	kh	x Classified as pharyngeal in *tajwid* (see Chapters Two & Three).
8	Apico-alveolar stop	d	d	
9	Interdental fricative	ð	dh	
10	Alveolar trill	r	r	It has plain and emphatic allophone ([r] vs. [ṛ]).
11	Lamino-alveolar fricative	z	z	
12	Lamino-palatal fricative	s	s	

No	Label	Phonetic Symbol	Transliteration Symbol	Other symbols used in the text/Comments
13	Palatal fricative	ʃ	sh	
14	Lamino-alveolar fricative (E)	ṣ	ṣ	
15	Lateral stop (E)	ḍ	ḍ	See Chapter Two for the Articulation of this sound
16	Apico-alveolar stop (E)	ṭ	ṭ	
17	Interdental fricative (E)	ð̣	dh	
18	Pharyngeal approximant	ʕ	c	
19	Uvular fricative (E)	ʁ	gh	ɣ Classified as pharyngeal in *tajwid* (see Chapters Two & Three)
20	Labio-dental fricative	f	f	
21	Uvular stop (E)	q	q	
22	Velar stop	k	k	
23	Alveolar lateral	l	l	Has emphatic and plain allophones ([ḷ] vs. [l]).
24	Bilabial nasal	m	m	
25	Alveolar nasal	n	n	
26	Glottal fricative	h	h	Classified as pharyngeal in *tajwid.*
27	Glide (semi-vowel)	w	w	
28	Glide (semi-vowel)	j	y	
29		ɑ: æ a(:) ɛ(:) ə	a ā	Phonetic symbols Representing Conditional allophones (see Chapter Three).
30		u(:)	ū	No symbols for different allophones (see Chapter Three).
31		i(:)	ī	No symbols for different allophones (see Chapter Three)
32	Nasality	˜		
33	Lowered	˕		
34	Long duration	:		Used with both vowels and consonants.

ABSTRACT

This study deals with the phonetic and phonological performance of expert reciters of the *Qur'an*. Experts constitute a special group of speakers who receive intensive oral instruction in *tajwid*, the traditional discipline of correct and ideal recitation of Classical Arabic.

The study falls into five chapters and a conclusion. The first chapter gives a general idea about the history of Arabic and *tajwid* and outlines the basic principles that underlie the standardization of recitations. The second chapter discusses some basic rules of *tajwid* and explores their scope. It sheds some light on the relation between *tajwid* and current phonological theory and physiological phonetics. The third chapter reviews the literature, both traditional and modern, on emphasis in Arabic. The review discusses the articulatory, acoustic and perceptual properties of emphasis in a variety of Arabic styles, and discusses the phonology and phonetics of emphatic coarticulation and the implications it could have for the linguistic grammar of Arabic, including implications for autosegmental theory.

The fourth chapter reports the results of an acoustic experiment. We consider the measurement values of the second formant of the vowel /a/, which both *tajwid* scholars and modern phoneticians claim it exhibits a greater amount of emphasis than other vowels. The phonetic environments examined are both emphatic and plain. The experiment manipulates three main dimensions: (i) expert vs. non-expert reciters, (ii) Classical vs. Modern Standard Arabic, and (iii) four vowel contexts: plain-to-plain, emphatic-to-emphatic, emphatic-to-plain and plain-to-emphatic. One main finding is that emphasis is a unary and gradient feature that has a range over which it can be phonetically realized. We suggest that plainness is apparently a zero or default value that is shared by all speakers and styles. Another finding is that the traditional distinction between experts and non-experts could be objectively verified from their acoustic data.

The fifth chapter explores the implications of the experiment for current theories of the phonology-phonetics interface. Emphatic assimilation is discussed within the framework of theories of phonetic underspecification, coarticulation resistance and hyperarticulation. We attempt to find out whether the vowel in an emphatic environment is categorically specified for emphasis or it is rather left underspecified for this feature. Although some of the acoustic measurements conform with a phonetic reading of emphasis on the vowel some others could be taken to imply that emphasis in Classical Arabic does not involve a case of phonetic underspecification. Finally, the conclusion summaries the main findings of the thesis in the light of the experimental study, the literature review and the phonological theories that were considered in the discussion, and it makes recommendations for future studies.

CHAPTER ONE
INTRODUCTION

1.1 The Arabic language

The language investigated in this study is Arabic. The aim of this chapter is, therefore, to give the reader a brief description of Arabic, the styles investigated and the focus of the entire thesis in general. A brief historical sketch is also given, but since our study is not mainly concerned with the history of Arabic the reader may prefer to consult some specialized works on the subject some of which are cited in the Bibliography.

Arabic is one of the major languages of the world. It is spoken by more than 183 million native speakers, the majority of whom live in the Middle East. Arabic is often linked to Islam since it is the language of the *Qur'an*, the principal book which Muslims whether native or non-native speakers of Arabic mainly use for religious purposes.

Historically, Arabic is one of the Semitic group languages which also includes Akkadian, Phoenician, Aramaic and Hebrew. It branches into Southern Arabic and Northern Arabic. The first inscriptions in Southern Arabic can be traced back to the 8th century B.C. They include the Sabaen, Qabtanian, Minaeanian and Himiyarite languages. These languages were spoken by ancient civilizations founded in or around the Arabian Peninsula. Southern Arabic, which is similar to Northern Arabic in grammatical forms and vocabulary, is no longer a living language. Northern Arabic was first attested much later than Southern Arabic. It is not until the 6th century A.D. that we have information about Southern Arabic that appears to have developed into the language of the *Qur'an* in the following century (Chejne 1969).

1.2 Contemporary varieties of Arabic

This study deals with two contemporary standard varieties/styles of Arabic: Classical Arabic (CA) and Modern Standard Arabic (MSA).[1] CA enjoys its social status because of its cultural significance and literary usage in early poetry and prose as well as for its religious use in the *Qur'an*. MSA, which is also known as Modern Literary Arabic and Modern written Arabic (Al-Ageli 1995), is more or less a modern and modified secular version of CA. Both styles are formally taught to native speakers from early childhood.[2]

Is there a significant difference between CA and MSA? In fact, one of the ultimate objectives of this study is to answer this question. Al-Ageli (1995) states that the average Arab does not generally distinguish between the two styles assuming they are the same. Nevertheless, each style has its own linguistic aspects which keep it separate and distinct from the other. This point may be unexpected especially by non-native speakers of Arabic and also some native speakers who have little education and/or knowledge about CA.

The use of CA is today preserved for the *Qur'an* while MSA is widely adopted for both religious and non-religious purposes that cover mass media, formal education, modern literature, correspondence and speeches. "[MSA] contains to a large extent the grammatical traditions of [CA] but is also incorporates stylistic and vocabulary innovations" (Al-Ageli 1995: 7). We expect that such innovations are a normal consequence of some major social, political and economic changes in the general life-

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[1] The abbreviations 'CA' and 'MSA' will be used throughout the study in reference to Classical Arabic and Modern Standard Arabic, respectively.

[2] The two styles are not necessarily taught as separate styles in every country in the Arab world because social interests and educational policies may differ from one country to another.

style of modern Arabs especially after recent technological developments that have affected humans' social habits and linguistic behaviour in various ways. In other words, we should not claim that CA and MSA are the same type of linguistic phenomenon while there exist more than one indicator that they are not.

MSA has diverged from CA, i.e. they are historically related, and it has undergone a variety of linguistic changes. The vocabulary and style of MSA have been probably more liable to changes and modifications than other components such as the grammar and phonology. For example, the use of technical terms, new expressions, borrowings from non-Semitic languages such as English and French are very common in MSA.

The language style which is not dealt with in this study is colloquial or vernacular Arabic. Colloquials are widely spoken but they are not written except for special purposes such as folk poetry and certain comic usages of the language. The fact that most Arabic colloquials are not written or documented probably allows them to change more rapidly than written styles, such as MSA, and it could also lead some of them to die off gradually. Whether they are written or not, however, they are usually recognized as informal varieties of one single standard mother tongue which is CA.

Although there have been some religious, political and literary attempts and invitations to retain CA and MSA as the only styles that can be used in press the advocates of some colloquials succeeded in publishing their writings in colloquial. A living example is Bedouin or folk poetry, conventionally known as *al-shi*ᶜ*r al-nabaṭi*, in the Saudi Arabian press. It is a literary style which has a large audience of educated readers, and is further characterized by its own formal and literary lexical usage, expressions and technical characteristics that include rhyming scheme, rhythm and meter. Nevertheless, no one can deny that Bedouin poetry is a colloquial variety. In fact, for this reason it is occasionally called 'colloquial poetry'.

There are many conceivable reasons that could have contributed to the use of colloquial for literary purposes in press. These reasons do not necessarily express negative social/psychological attitudes towards CA or MSA which still enjoy a respectable status among educated speakers.[3] The flourishing of colloquials may rather express speaker's desire to express themselves in non-standard varieties of Arabic and innovate or develop current literary styles.

The sociolinguistic relationship between the three varieties so far discussed in schematized in Fig. (1) below.[4] CA appears at the top of the triangle to express its religious, literary and social significance among all speakers whatever their level of education or social background might be. In this case CA stands as the primary linguistic source from which the other styles have diverged. Closely below CA comes MSA, the secular and modern version of CA. They both are similar to each other. Colloquials come at the bottom of the triangle to express the fact that (i) they are considerably different from the other two standard styles and from each other, and (ii) they are used by both educated and non-educated speakers. In other words, the

[3]It should be noted that colloquials have received more scholarly attention than the other two styles especially in the second half of this century.

[4] Trudgill (1974) similarly adopts the triangle so as to express the difference between Received Pronunciation (RP) and some other varieties of English which he calls low/non-standard varieties.

number of those who can speak the other two styles is smaller. For further discussion on the problem of diglossia in Arabic see Abou-Seida (1971) and Altoma (1969).

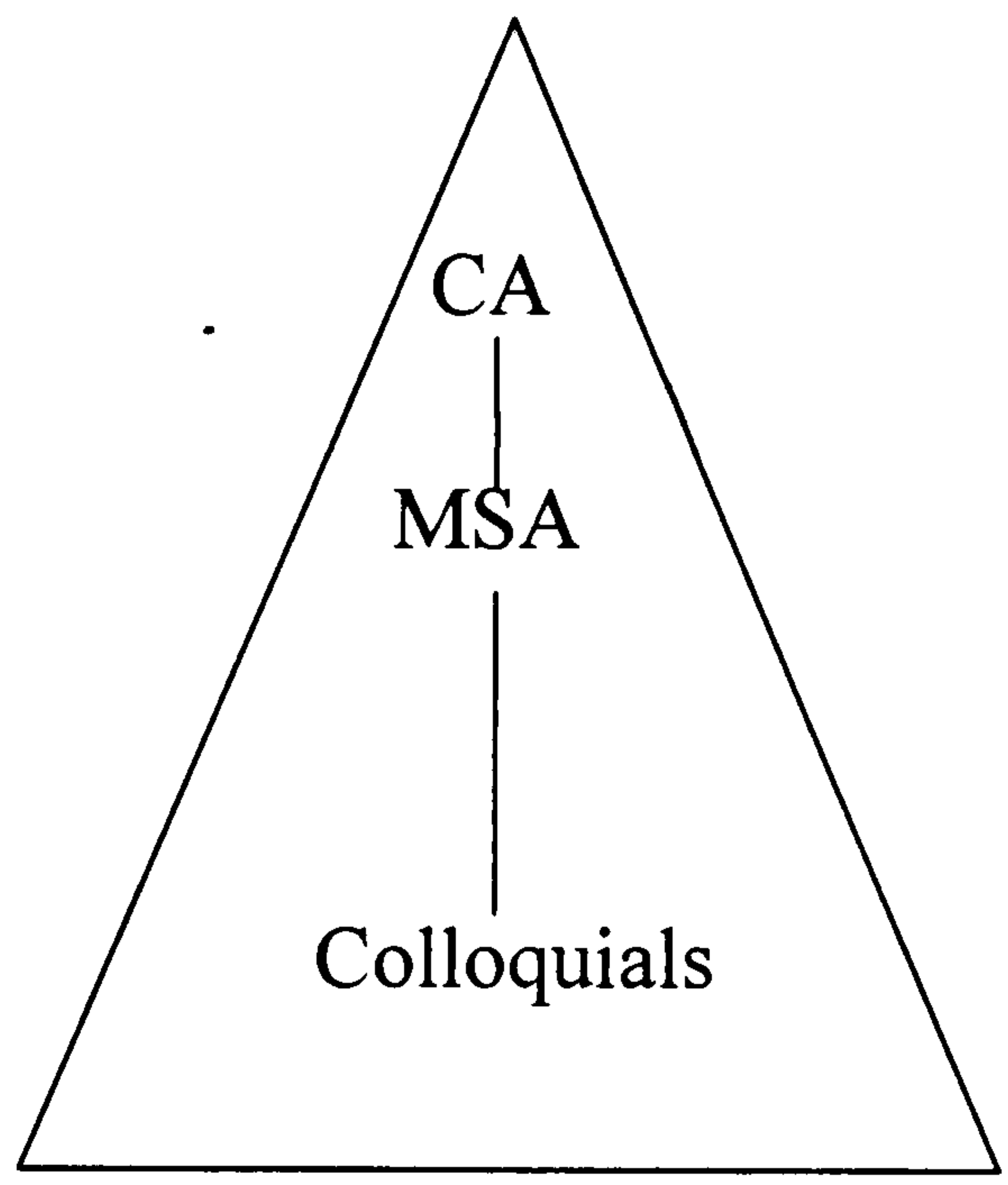

Fig. (1): The sociolinguistic relationship between contemporary Arabic styles according to their significance and diversity

Some linguistic aspects of Arabic styles are worthy of further investigation. Because of the great similarity between CA and MSA especially when they are compared to colloquials it is expected that the two standard styles show more similarities and fewer differences between each other than if either of them is compared to any colloquial style. For example, CA and MSA use the same number and kind of segments. Although those segments are not necessarily articulated exactly the same way in both styles a comparison between them and the segments found in any colloquial dialect will probably show greater differences such as significant sound changes and the adoption of segments that do not occur in CA/MSA. That is probably one of the reasons why some native speakers of Arabic with little or no education think that CA and MSA refer to essentially the same style and that cantillation (i.e. reciting the *Qur'an* with melody; chanting) is the only property that distinguishes the former from the latter. But since there are considerable differences between CA and MSA even though they could sound similar, as it will be seen later, we can continue to consider them two different styles adopted for different speech purposes. Our impressionistic judgement about the existence of significant differences between CA and MSA will be, indeed, tested objectively using acoustic analysis.

1.3 Recitation: historical approach and definition

1.3.1 Early oral performance: the Seven Variants

Prophet Mohammed (d. 632) advised his followers to recite the *Qur'an* according to what is conventionally known as *Al-'Aḥruf Al-Sab^{c}ah* 'the Seven Letters/Variants'.[5] The meaning of the Seven Variants is controversial in the literature available and there have been serious attempts to interpret it closely and to know what has happened to those variants since the lifetime of the Prophet. Scholars have also addressed the question whether the early Seven Variants and the contemporary Seven or Ten Recitations (see below) are the same or different. This is basically a historical and religious issue that is not the focus of the present study. We will, therefore, provide the reader with a brief historical approach and some definitions that might be relevant. For further information about the early oral performance and recitations see Ibn Al-Jazari (d. 1429), Ibn Mujāhid (d. 936) and Al-Dhahabi (d. 1328).

[5] In traditional Arabic grammar *ḥarf* refers to 'letter' which is either a consonant (or possibly a syllable composed of a consonant plus a short vowel) or the letter that represents it in orthography.

It seems that the Seven Variants were originally seven popular ancient Arabic dialects spoken in the Arabian Peninsula centuries ago. Nelson (1980: 315) states that these variants "govern differences in noun, gender and number, in verbal tense and mood, in inflection, adding or dropping or words, differences in word order, in substitution, and in what are called dialectal differences such as pronunciation of /a/, assimilation and velarization". Al-Qurṭubi (cited in Nelson 1982) argues that the Seven Variants are not actually seven in number but they are rather a mixture of all local ancient dialects. Whether the previous explanations of the meaning of the Seven Variants are accurate or not, scholars assume that the *Qur'an* was recited according to several models each with its own linguistic characteristics. The original model, they believe, is the dialect spoken by Quraysh, the prestigious tribe of Makkah which enjoyed a special significance among the ancient Arabs for its religions, literary and commercial status. With the increasing number of reciters, the Quraysh dialect gradually became essential to speakers from other Arabian tribes such as Banū-Tamīm, Qays, Hudhayl, Banū-Asad and Rabī ᶜah.

But why was not the *Qur'an* recited according to one single model, and what did that imply to both native and non-native speakers of Arabic in the early history of Islam? The dialects spoken by the ancient Arabs were not necessarily similar. It was quite common that a speaker from one region would encounter difficulties in speaking or understanding the dialect of a speaker from another region. Some speakers were also literate and others were elderly and/or had little education. These were among the reasons for the emerging several recitation models so that speakers were able to select the models they would prefer. This procedure was intended "to facilitate reading and provide people with a broader range of options" (Al-Wohaibi 1982: 58). Contemporary recitation scholars assume that the recitation models that came to be popular today have originated from at least one of the Seven Variants.

1.3.2 Qur'anic manuscripts (*Maṣāhif*)

The *Qur'an* is both spoken and written. The early manuscripts were composed of simple materials such as pieces of papyrus, palm branches and bits of leather, and they were written down under the supervision of the Prophet. But the entire *Qur'an* was not compiled into one single volume that contained all of its relevant chapters until the era of the first Caliph Abū-Bakr Al-S̱iddīq (d. 633). In 653 the Caliph ᶜUthmān bin ᶜAffān could publish the *Qur'an* manuscripts (known as *maṣāḥif* 'manuscripts') and appointed authentic teachers to teach recitation to both native and non-native speakers of Arabic. The manuscripts published by ᶜUthmān were at the beginning written with consonantal letters only (following the early Arabic orthography). Speakers were expected to use their own intuition and knowledge of Arabic for the prediction of the missing vowels. So, they could not rely heavily on word spellings. Until then Arabic orthography had not yet been improved and, as stated by Al-Qubaysi (1988), the majority of speakers used to memorize verses from the *Qur'an* without having to read them from a written text.

The first improvement to the Qur'anic manuscripts (and to other texts in general) was the adoption of *ḥarakāt* 'vowelling marks/diacritics' by the early grammarian Abu-Al-Aswad Al-Du'ali (d. 688). Vowels could thus have their own symbols like consonants and the Arabic segments became more identifiable. It was expected that such an improvement would help speakers not to disregard the linguistic structures of utterances or corrupt their semantic value.

The second improvement was the insertion of dots/points above or underneath certain consonantal letters which were otherwise confusing because they were quite similar to each other. The dots were introduced during the era of the fifth Caliph of Banī 'Umayyah ᶜAbdul Malik bin Marwān (d. 685). But it seems that the dots and diacritics were so similar that the early Arabian grammarians Al-Khalil (d. 791), who lived during the ᶜAbbāsi Period, decided to carry out some modifications on them. For further discussion on the early Qur'anic scripts and their relation with the contemporary prints of the *Qur'an* see Denffer (1989) and Al-Qubaysi (1988).

The question whether the Caliph ᶜUthmān included the early Seven Variants in the published manuscripts or only documented the original variant of Quraysh is controversial. Part of the problem is that scholars have not been able to reach an agreement about the meaning of the Seven Variants. For example, Naṣr (1992) states that ᶜUthmān only included the Quraysh variant which was originally the primary or principal style and excluded the other six variants which, according to him, were temporary models that were not supposed to be used after the death of the Prophet. Al-Wohaibi (1982), on the other hand, argues that all the early recitation variants were included in the ᶜUthmāni manuscripts. That is apparently a linguistic problem which possibly involves a number of historical issues about the development of Qur'anic script. However, the crucial point is that the entire *Qur'an* was written down and documented several times since the 6th century A.D. and that the writing up process was meant to represent its pronunciation as closely as possible.

1.3.3 The emergence of the Ten Recitations

It was indicated above that the precise meaning and scope of the early Seven Variants of the *Qur'an* is controversial. Nevertheless, scholars agree that the *Qur'an* was originally recited by the Prophet and his followers according to several models that were sometimes considerably different. A second issue relevant to recitation practice is the existence of the contemporary recitation models traditionally known as *Al-Qirā'āt Al-Sab^c/Al-^{c}Ashr* 'The Seven/Ten Recitations' one of which is the Ḥafṣ-^{c}Aṣim Recitation which will be investigated in this study

According to Al-Wohaibi (1982), Ibn Mujāhid (d. 936) recognized about seventy recitation models that existed during his lifetime. We have no clear idea about the sociolinguistic factors that led to the emergence of those models or the extent to which they differed. But it seems that Ibn Mujāhid, among others, was thinking that it was pointless, if not confusing, to have so many recitations. The existence of many recitation models complicated recitations and it gradually created a gap between reciters and the recommended recitations they were supposed to follow. Therefore, he decided to do extensive research in order to assess all the recitations he could come across. He traced the origins of those recitations and revised the biographies of the scholars who adopted them and their principal students. He assessed the adequacy and reliability of the recitations using a number of linguistic, social and religious criteria which he thought were essential. Finally, he selected seven models, documented and included them in his scholarly work mentioned above (see section 1.3.1) which is used today for academic purposes. With the exception of the seven models approved by Ibn Mujāhid it became indubitable that other models were no longer valid. The followers of Ibn Mujāhid added three recitations later so that the total number of the accredited recitations rose to 10. Al-Wohaibi (1982) also lists four reciters who were added later by some scholars (see Appendix III for the names of the major reciters). For further discussion on the work of Ibn Mujāhid and the criteria he used see Qal^{c}ahji (1986).

In spite of the significance of the contribution of Ibn Mujāhid and his followers to recitation Ibn Al-Jazari (d. 1429), a well-known authority, argues that the main disadvantage of limiting the number of recitations to ten or fourteen is the ruling out of what was beyond them regardless of the possible originality of the excluded styles (Al-Wohaibi 1982). But it is worth noting that, particularly after the work of Ibn Mujahid emerged, the acquisition of recitations has become more systematic than ever before and speakers could further avoid confusion regarding the appropriate classical pronunciations.

The controversy about the meaning and scope of the Seven Variants and the validity of limiting the number of acceptable recitations to any given number may not be totally resolved. Al-Wohaibi (1982: 60) states that "what is important is not to reach a single overriding conclusion but rather to present, in a somewhat detached manner, some of the questions which have confronted Qur'anists and Arabic linguists. Debates like these and new ones as well will surely continue and will enrich linguistic Qur'anic study. A healthy stance is one that is expansive enough to consider various perspectives, to perceive the strengths and possibly the flows of each. In this way, scholar's specialized work in the *Qur'an* and the *qira'āt* (recitations) will contribute to their larger insights in the realm of languages".

1.3.3.1 Differences between recitations

There exists no single recitation model that is followed by all speakers of Arabic. The selection of any model(s) could be influenced by different social and psychological factors that include the educational policies adopted in different Arab countries, the field of study of speakers, social interest in recitations and perhaps the familiarity of some recitations to speakers who come from different social and linguistic backgrounds. The following are basic differences between recitations:

(i) The treatment of assimilation.

(ii) The treatment of *imalāh* 'inclination', i.e. pronouncing the low front vowel /a:/ as [ɛ:], which is more common in certain recitations than in some others.

(iii) Substituting certain sounds for some others such as in [ʔannabi:ʔi:n] instead of [ʔannaijji:n] 'the prophets' where the mid glottal stop in the former replaces the geminate glide in the latter.

(iv) Vowel replacement in initial and mid positions as in [ʔalbuju:t] instead of [ʔalbiju:t] 'the houses' where either mid /u/ or /i/ is used depending on the recitation model selected.

(v) Differences in case endings, i.e. the vowels that come in final position to indicate grammatical function. For example, the subject of a sentence can be turned into the object and (or the other way round) by changing word endings of the surface.

(vi) Differences in the treatment of pause and silence periods within individual words or across word-boundary (see Chapter Two).

(vii) The use of different lexical items that have a similar meaning such as *fatabayyanū* 'be careful' and *fatathabbatū* 'make sure'.

1.3.3.2 Ḥafṣ-ᶜAṣim Recitation and current status

The recitation model examined in this study is traditionally known as *Riwāyat Ḥafṣ ᶜan ᶜAṣim* 'The Recitation of ᶜAṣim on the Authority of Ḥafṣ' (henceforth Ḥafṣ-ᶜAṣim Recitation). ᶜAṣim (d. 774) is one of the Ten Reciters. He learnt the phonetics and phonology of the *Qur'an* under the supervision of ᶜAbdul-Raḥmān Al-Sulami (d. 693) and the latter learnt recitation from a number of the companions of the Prophet including ᶜAli bin Abi-Ṭālib (d. 620). ᶜAṣim became the leading recitation scholar in Kūfah (Iraq) after the death of his instructor. According to Ibn Al-Jazari, he had been a reliable authority in the his area of speciality. Ḥafṣ (d. 796) on the other hand was the most prominent reciter from among the students of ᶜAṣim. One of the factors that could have contributed to the success of Hafs is the fact that he was directly brought up and looked after by ᶜAṣim himself. In other words, the student took every possible chance to acquire knowledge from his master who was probably preparing him to take over his job after his death.

According to Al-Wohaibi (1982), the Ḥafṣ-ᶜAṣim Recitation has been dominant for a long time especially since the printing of the *Qur'an* in the 19th century. Abu-

Sha^c^ar (unpublished) further states that other recitations are less popular such as the Recitation of Nāfi^c^ on the authority of Warsh in Morocco and some other African countries, the Recitation of Abū-^c^Amr bin ^c^Alā' on the authority of Al-Dūri in Sudan and in Somalia, and the Recitation of ^c^Abdullah bin ^c^Amir in Libya. It is not quite clear why Ḥafṣ-^c^Aṣim recitation has become the most popular in most Islamic countries. It is not also clear whether there exists some correlation between the choice of recitation models by different speakers and the styles they speak in ordinary situations. We could imagine that the similarity between formal/religious recitations, on the one hand, and informal/non-religious styles, on the other, could be one reason for the popularity of the former since speakers usually prefer the linguistic norms that sound familiar to them. That was exactly the reason the Seven Variants arose centuries ago. If all speakers from different regions were required to recite the *Qur'an* exactly the same way recitation was going to be difficult and embarrassing. And when Ibn Mujāhid initiated his research he went to approve the recitations that he thought were quite familiar to the majority of speakers.

1.4 *Tajwid*

1.4.1 Defining *tajwid*

The subject-matter of the present study is traditionally known as *tajwid*, literally means 'making good/correct' or 'improving'. It is adopted in early and contemporary Islamic and linguistic circles for the descriptive discipline of correct and ideal recitation. It also refers to the speaker's performance in accordance with the rules and principles which govern that particular discipline.[6] *Tajwid* is essentially a phonetic and phonological subject. It deals with principles of standard recitation practice and the rules of correctness and improving of recitation in addition to the control of pausing and silence. Although it contributes to the Ten Recitations, each according to its appropriate pronunciation detail, the knowledge of those recitations has a broader scope which goes far beyond what the ordinary educated speaker of Arabic is expected to learn about his mother tongue. The learner of *tajwid* is not expected to study all the relevant details of recitations for example or deal with their histories, schools and orthographies. He is merely engaged in recitation rules which are very essential to the phonological structure of utterances and their phonetic characteristics.

Various definitions of *tajwid* have been given by early and contemporary scholars who more or less agree on the following points:

(i) A correct/ideal recitation can be achieved if the reciter produces every sound segment from its appropriate point of articulation and gives it its 'full/original' values as well as its 'accidental/temporary' values in a fairly natural manner that has no exaggeration. 'Values' stands for manners of articulation and it can be taken to mean 'features'. These features are either original in the sense that they must always accompany the segment in all contexts, or temporary if their presence or absence is dependent on the segments that precede or follow it. The idea of giving the full value to each individual segment will become quite relevant at the experimental study in this

[6] A person who is a good reciter is sometimes described as *mujawwid,*, the adjective being derived from the same triliteral root *j-w-d* from which *tajwid* has been originally derived.

study where we will present empirical evidence that this is precisely what reciters with expertise in recitation attempt to do.

(ii) *Tajwid* is either theoretical or applied (Naṣr 1992). Theoretical *tajwid* is the formulation and presentation of recitation rules and principles, starting from places of articulation and ending with processes that result from putting segments together in strings to form larger utterances. There is a rich literature on theoretical *tajwid*, both traditional and modern. Applied *tajwid*, on the other hand, is reciting the *Qur'an* correctly according to the rules presented in the former. Both divisions are important, and they complement each other.

(iii) Mistakes in recitation are either *jaliyyah* 'clear' or *khafiyyah* 'hidden'. Clear mistakes cover all the changes in the phonemic structure of segments such as producing them from incorrect points of articulation or replacing them with other segments in the language. Clear mistakes may corrupt the meaning of utterances and can be observed by both expert and non-expert reciters because they are usually obvious (see below for the classification of reciters according to their expertise). On the other hand, hidden mistakes are of a completely phonetic nature and do not change the meaning of utterances, such as to discard some assimilations or to shorten the duration of a prolonged vowel. These mistakes are usually observed by expert reciters. We can call clear mistakes 'phonological' and hidden mistakes 'phonetic'. Recitation instructors are expected to help learners avoid both kinds of mistakes, but they give special attention to phonetic mistakes.

(iv) The acquisition of good recitation is best made through oral contact with teachers with some background on the subject. Written material is certainly helpful but it should not come first because *tajwid* is primarily an oral subject. It is quite possible to recite the *Qur'an* properly and to distinguish between phonological and phonetic mistakes by continuous oral practice. What the learner has to do, therefore, is to adapt his tongue and jaw to norms of correct recitation (Al-Faraj 1992), to listen to correct recitations regularly, and to avoid interference with other styles. Although Qur'anic texts include a set of phonetic symbols and pronunciation cues alongside verses in order to remind the reciter of certain rules, these symbols are not intended to be comprehensive. Besides, they do not generally teach pronunciation. In other words, the absence of a qualified teacher creates a gap between the speaker and the correct recitation.

1.4.2 Historical outline and comments

Various terms and expressions were used in the early Muslim society such as *tartīl* 'good recitation', *ḥaqq al-tilāwah* 'right of recitation', *taḥsīn* 'improving', *taḥbīr* 'idealizing' and *tajmīl* 'beautification' to refer to ideal recitation. Although the *tajwid* practice is not new in the sense that successive generations of scholars and experienced reciters have adopted the principle of acquiring and teaching recitations *tajwid* was not recognized as an independent field of study and research until the 10th century A.D. when an early scholar called Al-Khāqāni wrote a didactic poem consisting of 51 verses about the basics of correct recitation. According to Al-Hamad (1986), Al-Khāqāni's work had a great influence on the works that followed it. Before that the major contributions to the field of recitation were carried out by scholars with a broader area of speciality such as the Ten Reciters. Also, some early grammarians contributed to the birth and development of *tajwid* such as Al-Khalil (d.791), Sibawayh (d. 809), Al-Mubarrid (d. 898) and Ibn Jinni (d. 1001). Their works contained sections that dealt with pronunciation of CA segments including the treatment of certain features and phonological rules of assimilation.

The term *'tajwid'* was first adopted to designated the discipline that underlies ideal recitation by Ibn Mujahid, the scholar who originally approved the Seven Recitations. The same term was also used by Al-Saᶜīdi (d. 1023) who wrote a number of treatises on recitation including the common mistakes committed by ordinary speakers. But the term did not become popular until Makki (d. 1050) and Al-Dāni (d. 1052) wrote a number of scholarly works on the recitations (Al-Hamad 1986). Both scholars dealt with recitation principles in full detail. The centuries that followed witnessed significant writings on the subject including the works of Ibn Al-Jazari (d. 1429) which are still dominant in modern *tajwid* literature.

The early scholars used their own and some others' knowledge and studies of CA phonetics and phonology to serve as the basis to the systematic presentation of the new independent discipline. They gave considerable attention to the phonetic aspects of recitation, formulated a number of phonological rules and could also develop a special terminology to be used along with their discussions. But we should bear in mind that the *tajwid* phonetic descriptions are primarily impressionistic since the early scholars had no technological devices to analyze speech production experimentally. Therefore, the question of how far those scholars succeeded with giving anatomical pictures of the vocal organs activity while articulating speech sounds and how far modern phonetic findings are consistent with them is open to investigation. If such a question could be answered properly it might be then possible not only to analyze CA using modern phonetic tools but also to assess the accuracy and objectivity of the *tajwid* theory in its current status. It is quite possible that the traditional theory would undergo certain changes in the light of some modern experimental findings.

1.4.3 Classifying reciters into experts and non-experts

A skilled reciter is usually known as *shaykh* 'sheikh' or *muqri'/qāri'* 'reader/reciter'. From the point of view of the English reader, the former term is often linked to a political leader (particularly in the Arabic Gulf countries) whereas the latter is not specific enough. So, for the purpose of the entire thesis, we are going to adopt the terms 'expert reciter' and 'non-expert reciter'.

The question is that what does 'expert reciter' actually imply and why is an expert reciter different from a non-expert reciter? Also, on what basis could scholars judge that someone is an expert? Is the selection of a particular group of speakers to be called 'experts' based on an objective criterion? These questions will be investigated in this study. We have no clear idea about the criteria scholars adopt to judge whether a person is to be called an expert reciter or not. However, we expect that having a good command of certain rules and sound productions must be essential to the assessment of speakers' performance and their classification accordingly into experts or non-experts. The question whether the selection of experts has an objective basis will be considered in Chapter Four. We will describe below the requirements the learner has to fulfil in order to become an expert reciter.

Briefly, an expert reciter is a speaker (not necessarily native) who receives intensive oral teaching on one or more accredited recitations along with all the relevant phonetic/phonological details. The teaching may take a relatively long time (e.g. 24 months) before the learner is finally awarded a certificate known as *'ijāzah* 'approval/permission'. The certificate normally gives the names of all the reciters who took over the job of teaching the recitation(s) in question. It begins with the names of the new expert and the instructor who awards the certificate and so forth, until the chain of names is connected to the name of the Prophet who is traditionally regarded as the uppermost authority in the teaching hierarchy of recitations.

The second category of reciters represents the majority of speakers. Since people have varying degrees of education, abilities and interests they may not be interested in recitations the same way. But it should be made clear that is quite possible for many speakers to have a good command of recitations without having to study them in full detail. Expert reciters usually deal with phonetic detail information which the average educated speaker does not normally learn. It is possible to master *tajwid* by attending sessions which are organized for ordinary speakers who come from various cultural backgrounds and reading abilities. In other words, a good recitation is not a target that can be achieved only by experts. The fact that there exists a phonetic speciality within recitation does not contradict the possibility of having numerous reciters who do not hold recitation certificates and nevertheless have a good command of recitation.

1.4.4 Difference between *tajwid* and music

Tajwid is probably unknown to the majority of Western readers, both linguists and non-linguists. Some people may mistakenly think that *tajwid*, chanting and oriental music, in particular, are quite relevant to each other. Indeed, words that denote musicality such as *yataghannā* 'chant/sing' and *luḥūn* 'modulations' are traditionally associated with recitation. But they stand for moderate and acceptable chanting and reciting the *Qur'an* with a gentle and melodious voice quality. Nelson (1982), for example, says that "attempts have been made to regulate both the behaviour of reciter and listener and the sound of Qur'anic recitation itself in an effort to keep the recitation separate from music, whether sacred or secular. The main thrust of this regulation is maintaining the primacy of the text. Its divine nature must be compromised neither by the subverting of the performance so that listeners are moved by virtuosic musicality rather than by the significance of the text, nor by the recognized change that music can affect on a text" (p. 4). This description implies that *tajwid* and music need to be distinguished clearly. Therefore, it is not recommended that reciters follow the modals (*maqamāt*) practice of oriental music, study music in the course of their training on recitation or apply the principles musical contours to their recitations. Music does not only contradict the significance of the *Qur'an* to the people who recite it but it could also lead reciters to disregard its pronunciation rules. In fact, one of the major defects of chanting the *Qur'an* according to musical contours and rhythms, as it can be experienced, is that its *tajwid* aspects are often affected. For instance, following musical melodies could motivate the reciter to exaggerate the duration of short vowels or change the manners of articulation of some consonants. Some other practices are also characteristic to melodies and songs and they are not recommended in tradition such as to recite the *Qur'an* with *taḥzīn* 'excessive sadness', *tarqīṣ* 'dance-like quality' and *tarᶜīd* 'trembling of voice'. Scholars assume that the original intent of recitation is to draw the listener's attention to the meaning of the utterances and their religious values. This intent "goes beyond entertaining or stirring the emotions", as Nelson says (1982: 43). However, the use of moderate spontaneous melodies with a full appreciation of recitation rules is usually recommended.

1.5 Focus of the present study

This is a phonetic and phonological study of certain aspects of CA and MSA and it is not a religious or historical study. It has become clear from the preceding pages that the Classical Arabic tradition provides us with a considerable number of specially trained reciters who have devoted a lot of time and attention to control their speech for the purpose of reciting the *Qur'an* properly in a variety of sociolinguistic contexts.

Since one of the rules that *tajwid* deals with is assimilation, in one form or another, this provides us with a great opportunity to study the phonetic and phonological detail of assimilation in CA. The reader may be already aware that assimilation, in general, is a topic of a great current interest in phonetics and phonology because it is right on the interface or boundary between phonologically-governed behaviour and language-specific phonetics. The study of assimilation sheds more light on the relationship between phonetics and phonology.

Until recently it was traditional to describe assimilation in terms of phonological rules that affect segments in a categorical way. But more recently linguists have started to deal with this problem in terms of language-specific phonetic rules. For example, Cohn (1990) provides experimental evidence to demonstrate that anticipatory nasalization in English is the result of phonetic implementation rather than a categorical/phonological rule. In other words, she showed that nasal assimilation is not influenced by the linguistic grammar of English as it has been previously assumed.

By contrast, the patterns of nasalization in French and Sundanese (the latter is spoken in Indonesia) imply that it is categorical in both languages. We will discuss the details of Cohn's findings and shed some light on their relevance to the issue of phonetic-phonology interface later in Chapter Five after presenting the results of the experimental study.

One basic criterion for making objective judgements about the behaviour of assimilation in any particular language is the use of instrumental measurements. One of our objectives in this study is, therefore, to use measurements to investigate assimilation. We found that it is quite possible to make a number of acoustic measurements of clearly defined groups of speakers (experts as opposed to non-experts) and clearly defined differences of styles (CA as opposed to MSA). The value of these measurements or experiments is that they will hopefully manipulate those clearly defined variables so that we can appreciate the extent of effect of each variable on the assimilation behaviour. It might be possible to see whether assimilation in the styles studied is more categorical or more continuous, whether it is like phonology or like phonetics.

The above is a brief outline of the focus of the present study as a whole so that the reader will have an idea about its domain and scientific nature and the sort of linguistic problems and controversial issues it is going to raise. Because of the oral tradition which we can get access to through expert reciters, and because of the cultural importance attached to it, and because of all the people who are expert reciters and the people who are interested in recitation we will hopefully have a great opportunity to investigate assimilation in CA as a major linguistic problem in both tradition and modern linguistics.

1.6 Summary

The present study deals with CA and MSA, two similar standard styles of Arabic, the difference between which essentially lies in the former's employment of a group of phonological and phonetic rules generally known as the rules of *tajwid*. *Tajwid* is a theoretical discipline and it is also an applied area of study, based on the acquisition and control of oral performance. It is less technical and far easier than what is traditionally known as *ᶜIlm Al-Qira'āt* 'Knowledge/Discipline of Recitations' since it addresses a broad non-specialized readership.

The main focus of the present study is assimilation. We assume that the styles to be examined and the availability of expert and non-expert reciters will give us an opportunity to study assimilation from the perspective of the phonology-phonetics interface. We expect that the study of assimilation in CA will not only shed more light on the categorical or gradient nature of the phenomenon investigated in this style but it could also give some implications for the understanding and assessment of the *tajwid* theory in its current status.

CHAPTER TWO

PRINCIPLES OF *TAJWID* AND THEIR MODERN INTERPRETATION

2.1 Introduction

According to Bakalla (1994), *tajwid* is one of the main sources of Arabic phonetics. Our intention in this chapter is, therefore, to give the reader who is not familiar with *tajwid* a brief description of the main rules that the reciter has to follow, and to make critical judgements about them and the way they are presented in the literature. If we succeed in giving an objective description and commentary on these rules it might be possible to assess the assumption which says that *tajwid* is a useful phonetic source of CA and see the relationship between this traditional discipline, which is still appreciated by many speakers, and modern phonetics and phonology. We further hope it will be possible through this and the remaining chapters to fill in the present gap between the traditional and the modern, and between the impressionistic and the experimental. Before we present and discuss the rules of *tajwid* and their scope it might be useful to consider two points:

(i) *Tajwid* phonology deals with a number of theoretical issues and raises controversial problems some of which are not necessarily tackled in ordinary instruction manuals which are specially prepared for beginners. It might be true that the *tajwid* phonology is more prescriptive and less descriptive than some other phonologies because it is a pedagogically-designed discipline that addresses a large number of audience who come from different cultural backgrounds. *Tajwid* is generally concerned with providing a sensible and straightforward theoretical approach to rules and basics of ideal recitation, leaving out sophisticated theoretical discussions for people with more specialty in **field**. Scholars put stress on the practical side of recitation; in oral practice through which numerous pronunciation defects and difficulties can be observed and treated.

(ii) It is not our intention in this chapter (nor in the entire thesis) to deal with pedagogical issues or to judge the adequacy of traditional descriptions to modern recitation learners. This problem could be of a special concern to applied linguists, recitation teachers and some other people engaged in the preparation of *tajwid* manuals.

2.2 *Tajwid* terminology

Our purpose in this section is to explain the meaning and usage of basic terms commonly found in *tajwid* books and manuals particularly because these terms, or some of them, are used throughout this study. Note that it is not our intention in this study to make critical judgements about terminology. The terms are arranged alphabetically according to their meaning in English while the original term is enclosed between brackets.

2.2.1 Assimilation *(al-idghām)*

Idghām is he integration of two adjacent consonants. The traditional approach to the problem of assimilation, especially the sounds that undergo assimilation, differs significantly from the modern approach. It will be shown in the following chapters that assimilation is essential to standard recitation and that it can provide useful insights into our understanding of the problem of careful speech and the phonology-phonetics interface.

2.2.2 Diacritic (*ḥarakah*)

A diacritic is basically a symbol written above or underneath consonantal letters to serve as a reader's guide to the identification of short vowels which are not represented by letters in Arabic orthography unlike consonants. The basic three diacritics used to represent short vowels are *al-fatḥah* (َ—) for /a/, *al-ḍammah* (ُ—) for /u/ and *al-kasrah* (ِ—) for /i/. Long vowels are represented by letters like consonants. Other diacritics are *al-shaddah* (ّ—) for gemination and *al-sukūn* (ْ—) for absence of a vowel (see section 2.2.5 below). It was indicated above that the use of diacritics was an important improvement to the writing system of the early Qur'anic manuscripts. Short vowels, or diacritics in this particular sense, have a number of functions including the indication of grammatical functions such as the subject and object of a sentence.

In order to describe and quantify the duration of vowels, which fall into the categories short, long and prolonged, and extended nasality (see the definition below) scholars use the duration of a short vowel, without specifying any particular vowel, as a reference measurement tool for the reciter to follow. This duration is referred to as a 'diacritic'. What is the actual time required to produce a diacritic? In ordinary speech or when reading out an ordinary text speakers usually encounter no difficulties at producing appropriate vowel durations. But since some of the rules of *tajwid* put emphasis on long durations that do not exist in ordinary speech, scholars probably think that it is wiser to use a particular term in reference to the measurement of vowel duration. According to Abu-Sha^{c}ar (1996) the initial measurement tool was at the beginning the duration of the vowel /a:/. The early scholars suggested that this vowel has the duration of two diacritics and they used it to measure the duration of vowels and some other segments. Scholars later adopted the concept that the duration required for a diacritic is equal to the time required for folding one's finger in one direction neither quickly nor slowly (Marṣafi 1982). Such impressionistic measurements are, indeed, consistent with the fact that the early *tajwid* scholars had no technical devices to measure time duration.

2.2.3 Extended nasality (*madd al-ghunnah*)

Extended nasality is one of the significant *tajwid* rules. It stands for extending or prolonging the duration of the nasal air which escapes through the nasal and possibly oral cavities. *Tajwid* teachers and manuals provide information on how to manage the production of extended nasality including its appropriate time durations which are measured in terms of diacritics (see above).

It seems that extended nasality hardly exists in other styles of Arabic. It is probably a significant phenomenon because the speaker has to control the volume of the air escaping through either the nose alone or a long with the mouth. It is also affected by the shape of the tongue so that the articulatory and auditory properties of the nasal sound become different. Extended nasality could be one of the rules that make CA differs significantly from other styles, and it contributes to its characteristic timbre, rhythm, and general 'musicality'.

2.2.4 Nunation (*al-tanwīn*)

The term 'nunation' is used in a number of modern English works on CA such as Bakalla (1984) and Al-Wohaibi (1982). In Arabic grammar, nunation represents special usages of case endings where it indicates the accusative, nominative and genitive cases. In writings nunation is indicated by the duplication of diacritics. It is called nunation probably because its pronunciation ends with [n] sound in the suffixes {-an,-un} and {-in}.[7]

2.2.5 Unvowelled (*sākin*)

If a consonant is not followed by a vowel it is often described as *ḥarf sākin* 'quiescent letter/sound' in tradition. Different English terms are adopted by Arabists for a quiescent letter such as 'unvowelled' (Bakalla 1982), 'nonvowelized' (Osman 1988 and Al-Wohaibi 1982) and 'vowelless' (Denny 1989). These terms may give the original meaning intended by *tajwid* scholars and grammarians but 'quiescent' could be more accurate not only because it could sound more familiar to the English reader but also because it is an accurate literal translation of *sukun* 'quiescence' which is used as an analogy to distinguish between consonants which are followed by consonants (unvowelled) and consonants which are followed by vowels. Like nunation, unvowelled consonants are very essential to the application of a number of assimilation rules in CA.

[7] The duplication of the three diacritics make them appear as (ـً), (ـٌ) and (ـٍ).

2.3 *Tajwid* rules

2.3.1 Places of articulation of CA segments (*makharij al-huruf*)

Knowledge of the places of articulation of CA serves as the basis for what is traditionally described as pure or eloquent. Following tradition and possibly modern phonetic approaches to the study of articulation, modern *tajwid* literature adopts the concept of ascribing segments to a relatively small number of general places of articulation and a larger number of narrower or more specific points of articulation.

The descriptions given today in the literature are basically impressionistic, i.e. they are based on personal observation and experience rather than experimentation. Nūr Al-Dīn (1992) says that the research studies carried out by the early scholars such as Al-Khalil (d. 791), Sibawayh (d. 809) and Ibn Jinni (d. 1001) on the places of articulations resulted from individual introspection and speculation, but the scholars were also objective with their observations about phonetic phenomenon, and their findings do not differ significantly from the findings of modern phoneticians. And when Nūr Al-Dīn (1992) comes to describe the methodology adopted by Sibawayh who can be considered the father of Arabic Grammar (Bakalla 1992) he says that it was a realistic one, based on personal observations, but at the same time it was not affected by radical assumptions and misguiding interpretations. The early scholars encountered difficulties in order to provide their students, their contemporaries and the following generations with accurate descriptions of sound mechanism. They had no phonetic tools or technical devices to use in their studies. Nūr Al-Dīn raises the argument that the early descriptions adopt a methodology which looks acceptable in modern phonetic studies - a methodology which gave rise to good findings later on.

The early descriptions are still influential on modern literature and modern scholars consider them the basic criterion against which the reciter's articulation can be evaluated. We will consider below the places/points of articulation in a greater detail and attempt to assess traditional descriptions from a modern perspective.

The places of articulation from which all CA segments are produced are 5 defined as follows:

(i) *Al-jawf* 'the hollow' which is the oral passage or oral cavity extending from the larynx upwards to the lips. The hollow sounds are the six vowels /i, a, u, i:, a:, u:/. Hollow sounds have no specific points of articulation like consonants due to the way they are articulated. Each vowel has, therefore, *makharj muqaddar* 'an estimated outlet'. The majority of scholars believe it is not clear which of the vocal organs are involved in the production of vowels. Because Arabic *jawf* stands for the oral cavity while the nasal cavity is not included in its meaning we conclude that CA has no nasal vowels and that the nasalization of vowels is not recommended in tradition.

(ii) *Al-ḥalq* 'the pharynx/throat' which contains the points of articulation of the laryngeals /ʔ/ and /h/, the pharyngeals /ħ/ and /ʕ/ and the uvulars /ʁ/ and /χ/.

(iii) *Al-lisān* 'the tongue' which is the active articulator of 18 consonants: /q, k, dʒ,ʃ, j, ḍ, l, n, r, ṣ, s, z, ṭ, d, t, ð̣, ð/ and /θ/.

(iv) *Al-shafatān* 'the two lips' which is the active articulator of the four labials /f, w, b/ and /m/.

(v) *Al-khayshūm* 'the nasal cavity' which is the nasal passage of nasal airflow that is produced for the production of nasals and nasality.

The significance of the taxonomy above lies in its implications. The early scholars and their contemporary followers appreciate that one possible method to be adopted when describing articulation is to classify sounds into major classes according to their general places of articulation. They consider both consonants and vowels in their taxonomy and further observe that vowels (which they occasionally describe as 'hollow' or 'airy') cannot be ascribed to well-defined points of articulation like consonants. The taxonomy further considers the pharynx and differentiates it from the hollow (the oral cavity). In the case of the tongue, it is indicated in the *tajwid* literature, as it is usually done in modern phonetic literature, that it is the main articulation of the majority of sounds. We can observe, however, that the articulation of vowels is not usually ascribed to the tongue in this approach and that the lips are reserved for the description of consonants. This is possibly one main difference between tradition and some modern studies that adopt the convention of classifying vowels according to tongue height and position. The consideration of the nasal cavity which is not merely used for the production of nasal stops but also for extended nasality sheds light on its direct relevance to ideal recitation. We will now discuss each of the five general places of articulation and their implications.

2.3.1.1 The hollow/oral cavity *(al-jawf)*

The problem of vowels and their treatment in *tajwid* is worth discussing. Versteegh (1997) is absolutely correct when he says that in Arabic "the consonants of the word carry the semantic load, whereas the vowels and auxiliary consonants provide the information about derivational and declensional morphology" (p. 26). The early Qur'anic scripts contained symbols that represented consonants while the vowel symbols were introduced some time later to help speakers to recite correctly. The fact that vowels were assigned their own symbols implies that the early scholars came to appreciate their significance in speech even though they do not have the same semantic function as the consonants.

The *tajwid* descriptions of vowels and their articulation have two main lines of argument. First, in spite of their significance as linguistic components which are quite essential to speech production, vowels remain phonologically subsidiary to consonants. The root of any single word must be entirely consonantal and it is possible to derive numerous lexical items, each having an independent meaning, by the application of vowels to the root. The assumption that vowels are subsidiary elements that must follow consonants could also mean that vowel production is an automatic articulatory consequence of the release of consonants (which is clearly heard with stops). That is probably why Ibn Jinni (cited in Ghali 1976) considers vowels to be fractions/components and followers of consonants.

The second line of argument in the traditional treatment of vowels is concerned with their articulation in the vocal tract. Ibn Jinni (cited in Bakalla 1982) classifies /a(:)/, /i(:)/ and /u(:)/ as pharyngeal, palatal and labial, respectively. He states that /a(:)/ is produced with the vocal tract open and unobstructed by contact or close stricture. For the production of /i(:)/ the molars are alongside the sides of the tongue and press it and the surface of the tongue is approximated to the hard palate; hence the airstream flows upwardly and because of this open passage the sound is continuant. In the case of /u(:)/, the greater part of the lips is brought together leaving only a small opening through which the breath passes and the voice continues. These descriptions definitely imply that some early scholars had a clear conception of how vowels are produced. The taxonomy of Ibn Jinni is interpreted in Fig. (2) below.

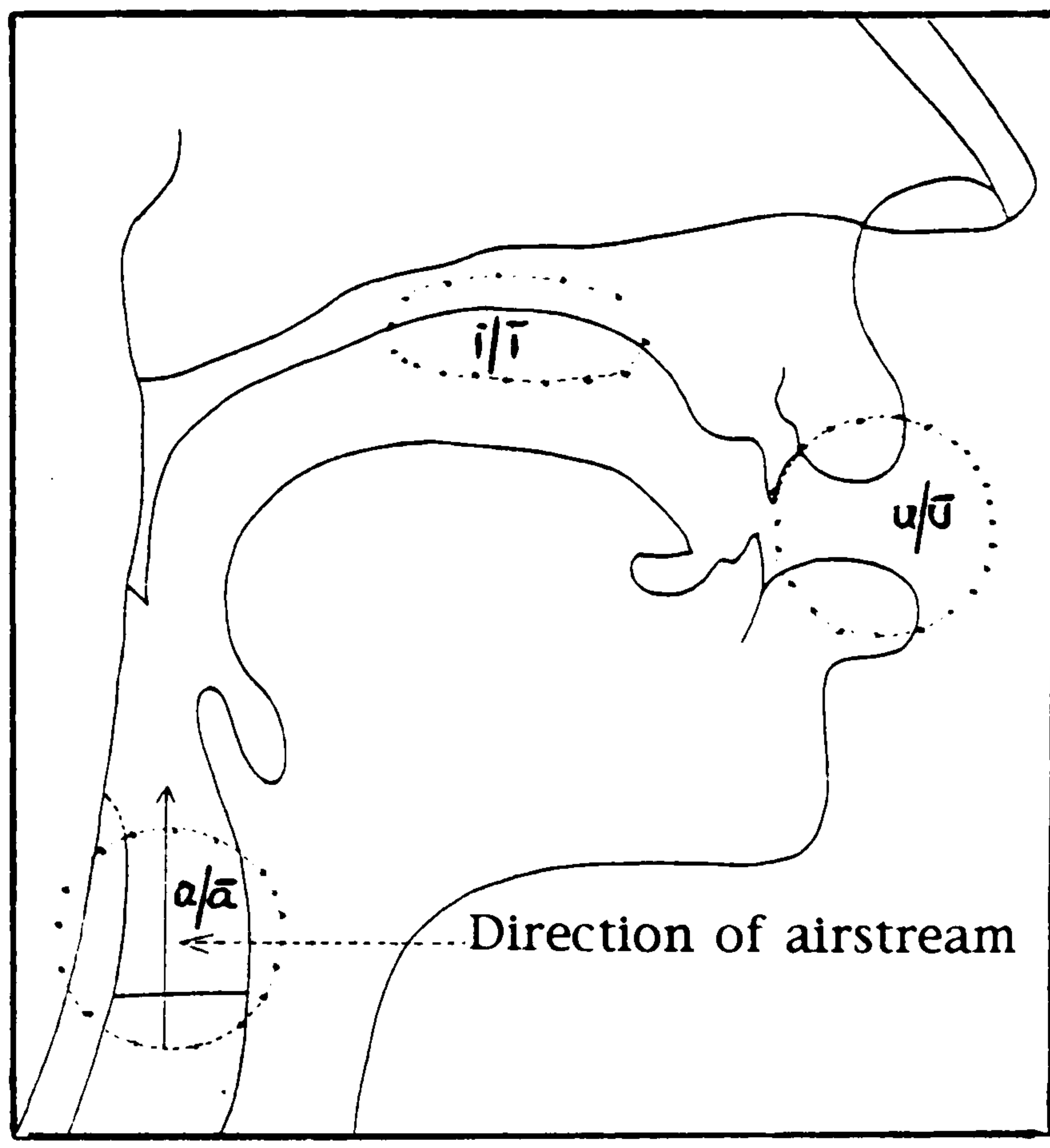

Fig. (2): Ibn Jinni's classification of the place of articulation of vowels
(Bakalla 1982)

However, not all the early scholars adopt the view held by Ibn Jinni. That, indeed, allows the controversy about how vowels are actually articulated to continue. For example, Ibn Sina (cited in Al-Ani 1994) states that the production of vowels is problematic to him and that their condition is not clear. Therefore, he devoted only a few lines to them. The same view is held by the majority of scholars. Accordingly, the dominant trend is to consider vowels placeless segments.

Actually, the production of vowels is not well-defined even in current phonetic theory. Ladefoged (1982), for example, does not seem to accept the conventional taxonomy of the vowels according to tongue height and position. He thinks that the conventional descriptions are just labels that describe how vowels sound in relation to one another, and he further states that it is easier to divide consonants into categories since the actual points of articulation are more distinct. In fact, Ladefoged (1972) expects that lip rounding may turn out to be the only true articulatory feature which is appropriate in the characterization of vowels. He further suggests that we should probably consider tongue height to be inversely equivalent to the height of F1 and tongue fronting to be equivalent to the distance between F1 and F2 and higher formants. Similarly, Russell (cited in Bakalla 1982) states that the tongue lacks conformity with 'open' and 'closed' vowels and that it may lie absolutely flat for all vowels. However, some phoneticians (e.g. Delattre 1971) argue that the vowel /a(:)/ is pharyngeal like Ibn Jinni.[8]

2.3.1.2 The throat/pharynx (*al-ḥalq*)

The throat sounds (pharyngeals) are divided into three pairs depending on their points of articulation /ʔ, h/, /ʕ, ħ/ and /χ, ʁ/. The first two sounds are produced at the very lower extreme of the pharynx (*aqṣā al-ḥalq*, i.e. the farthest point in the throat). There is nothing unusual about the traditional description of the point of articulation of the glottal stop which is occasionally described as a laryngeal sound in modern literature (Bakalla 1982). Al-Khalil (cited in Abu-Sha^{c}ar 1996) states that the

[8] The adoption of the concept that the tongue assumes particular heights and positions for the production of vowels and that these articulatory characteristics are the same for all speakers is not necessarily accurate. It might be possible that different speakers produce the same auditory/acoustic effects by different articulatory strategies when they articulate vowels. The *tajwid* approach may be, therefore, plausible. Vowels are described as hollow sounds that have the oral cavity as their general place of articulation but not any particular point of articulation. But we think it would be appropriate for modern *tajwid* writings to make an acknowledgement of the assumptions raised by the early scholar Ibn Jinni and modern phoneticians so as to allow recitation learners to benefit from the different views about vowel production.

production of the glottal stop is similar to someone's voice when he vomits or coughs. Similarly, Ladefoged (1982) states that this sound is produced right in the glottis by holding the vocal cords tightly together and releasing them and that "glottal stops occur whenever one coughs" (p.50). Ladefoged assumes that the speaker can get the sensation of the vocal cords being pressed together by making small coughing noises. This shows that the traditional and modern descriptions coincide. The production of the CA glottal stop may be difficult since the speaker has to consume a greater articulatory effort than for the production of some other sounds. Al-Dāni (cited in Al-Hamad 1988) states that because of the heaviness of its articulation (he is probably referring to pronunciation difficulty and/or the amount of articulatory effort required) Arabic speakers sometimes turn it into a light glottal stop or totally omit it from utterances. He also says that its point of articulation is deep in the pharynx. By considering that the scholars say its point of articulation is the lowest in the throat it becomes clear that /ʔ/ is a laryngeal sound and that people differ with the way they pronounce it in the pharynx.

The consonant /h/ is classified as a pharyngeal sound and its point of articulation is also the pharynx like /ʔ/. It is considered in *tajwid* a voiceless sound (Nasr 1992).[9] Al-Sa^{c}ran (1951) and Hassān (1979) give two different opinions about /h/. Al-Sa^{c}ran says that for the production of /h/ the oral cavity assumes a shape that is suitable for the production of a vowel and the airstream passes out freely through the glottis with the vocal cords being separate so as to produce a voiceless

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[9] The state of the glottis is discussed here for its relevance as a point of articulation. See section 2.4.2.2 for discussion of voicing and voicelessness.

fricative. On the other hand, Hassān assumes that the vocal cords are half-way between the closing and opening position so that the glottal narrowing in the glottis affects the articulation of the sound which is neither characterized by a clear vocal cords' vibration nor an audible breath (i.e. it does not sound voiceless). Abu-Sha^{c}ar (1996) assumes that the two phoneticians are actually describing different /ḥ/ sounds and that they both are correct. But he also states that the description given by Hassān is the one which fits more properly with the performance of contemporary expert reciters whose articulation of /h/ is usually accompanied by the vibration of the vocal cords. Does what Abu-Sha^{c}ar says imply that /h/ is voiced? What is the state of the glottis during /h/ production?

Abu-Sha^{c}ar (1996) attempted to answer these questions experimentally. He found that CA /h/ is characterized by the vibration of the vocal cords in addition to the production of a large volume of breath. In other words, it resembles voiced sounds in that the vocal cords are vibrating and, at the same time, it resembles voiceless sounds in the flow of breath. Using laryngoscopy, Abu-Sha^{c}ar found that the state of the glottis is between close and open. Visi-pitch studies indicated that /h/ is produced with vibration that yield a fundamental frequency trace. Spectrographic studies of the utterance *Allah* 'God' also indicated that the last segment (/h/) is produced with periodic sound. Nevertheless, Abu-Sha^{c}ar prefers to treat /h/ as a voiceless fricative on the basis that the vocal cords do not really assume the position they usually assume for the production of voiced sounds. He also cites Ladefoged (1982: 128-9) who says that "in most of the speakers of English I have been able to observe, the /h/ is made with the vocal cords slightly apart along their entire length, but still continuing to vibrate as if they were waving in the breeze. The term voiced *h* is sometimes used for this sound, but it is somewhat confusing as there is certainly no voicing in the usual sense. The term murmured *h* is preferable. The symbol for this sound is [ɦ]". Ladefoged says that the murmured [ɦ] is like a sigh produced with breathing heavily while in the voiceless [h] the air escapes very rapidly, so that this sound cannot be prolonged to any great extent. We tend to think that the classification of /h/ into murmured [ɦ] and voiceless [h] gives a sensible solution to the problem of how to account for the closing position of the glottis during the production of /h/ and the traditional description of this sound as a voiceless fricative. But the crucial point is that the point of articulation of /ʔ/ and /h/ is the larynx and that the traditional descriptions are correct.

Pharyngeal /ʕ/ and /ħ/ are produced in the middle of the throat (*wasaṭ al-ḥalq*) half the distance between the point of articulation of the laryngeals and the uvulars. However, the point of articulation of /ʕ/ is lower than that of /ħ/. Such a distribution of sounds over the pharyngeal area is actually ascribed to Sibawayh (Abu-Sha^c^ar 1996). The fact that investigating the pharynx requires the use of fine technical devices that were not available in the past is consistent with our observation that *tajwid* does not say that much about the production of pharyngeals. Although *tajwid* is not a very technical subject like experimental phonetics it might be appropriate to include a brief outline of the main physiological findings about pharyngeal articulation in modern *tajwid* literature. This will provide us with useful insights into the scope of the traditional descriptions and give a clear picture about pharyngeals. The traditional descriptions of /ħ/ and /ʕ/ deal with two aspects: their point of articulation and their manner of articulation (the latter will be discussed later). The middle of the pharynx for /ʕ/ has a lower point of articulation than for /ħ/. As it would be expected, *tajwid* writings do not give further articulatory detail since the anatomy of the pharynx and the mechanism that underlies the production of pharyngeals were unknown centuries ago. However, a number of modern phoneticians, including Delattre (1971), Butcher and Ahmed (1987), Ghali (1983 & 1989), Laradi (1983), Laufer and Baer (1988) and Laufer (1996), have shed more light on the production of pharyngeals.

Al-Wohaibi (1982: 124) states that "the pharynx is utilized in the production of the pharyngeal sound /ʕ/ and /ħ/ by narrowing the pharyngeal wall. The airstream causes the friction that characterizes both sounds and whereas the back of the tongue contracts towards the pharyngeal wall, the front of the tongue, by and large, remains neutral". But he does not indicate whether the back of the tongue refers to the part of the tongue which is raised in the production of uvulars and velarized consonants or it rather refers to its extreme end (the tongue root). Lee (1994), on the other hand, is more specific when he states that the pharyngeals "are produced with the primary constriction in the lower pharynx showing the narrowest constriction between the epiglottis and the pharyngeal wall" (p. 71). But he also does not mention the tongue in his description, unlike, for example, Laufer and Baer (1988) who state that the articulation of pharyngeals involves a backward movement of the root of the tongue at the bottom of the pharynx, and Wood (1996) who states that the tongue root is drawn into the lower pharynx, which is narrowed or occluded. On the other hand, Ghazeli (1977) reports that the larynx is raised during the production of pharyngeals. But we are still uncertain whether that is essential to their articulation or it is just an automatic bio-mechanical activity. The main points raised so far are:

(i) /ħ/ and /ʕ/ are pharyngeal sounds produced in the lower pharynx and their production is characterized by pharyngeal narrowing.

(ii) The tongue root and the epiglottis are quite essential to the articulation process of both sounds.

Two questions thus arise. First, is it the tongue root or the epiglottis which functions as the main articulator in pharyngeal articulation? Second, how far have the traditionalists been accurate in stating that /ħ/ and /ʕ/ are produced in the middle of the pharynx and that the point of articulation of /ʕ/ is lower than that of /ħ/? The question of whether it is the tongue root or the epiglottis which functions as the main articulator in pharyngeal articulation is a bit problematic. For example, El-Halees (1985) analyzed a xeroradiogram made of an Iraqi speaker during the articulation of /ʕ/. He argues that the root of the tongue is "retracted considerably and then lowered" (p. 299), and further assumes that the constriction is made with the back wall of the pharynx in the laryngopharyngeal cavity. The laryngopharynx is the inferior subdivision of the pharynx and, according to Kaplan (cited in Laradi 1983: 42), "its anterior wall is formed partly by the posterior wall of the larynx and it communicates with the larynx through the epiglottis". This clearly implies that it is the lower pharynx rather than any other area is the place of the stricture and that the tongue root could play a significant role in pharyngeal articulation. El-Halees conducted preliminary experiments with fiberoptic pictures that showed that the epiglottis is so far back and so low that it covers the laryngeal vestibule and makes a very narrow stricture with the back wall of the pharynx during the articulation of /ʔ/. McCarthy (1994) says that El-Halees considers the tongue root the active articulator in pharyngeal articulation. But it is worth mentioning that El-Halees himself describes the activity of both the tongue root and the epiglottis without identifying either of them as the active articulator. As a matter of fact, and particularly when we consider his preliminary experiments where he used fiberoptic pictures, there appears to be a strong indication that he considers both organs essential to the production process, and that both sounds involve backing (which he calls retraction of the tongue root) and lowering in the pharynx. Ghazeli (1970) appears to have a similar opinion. In his study of back consonants (emphatics) in Tunisian and some other North African dialects using cinefluorography he reached the conclusion that pharyngeals are characterized by retraction of the root of the tongue and slight forward displacement of the posterior wall of the lower pharynx resulting in a constriction at the level of the epiglottis. In other words, the description given by Ghazeli probably implies that the tongue root is the active articulator whereas the pharyngeal narrowing which can be traced at the level of the epiglottis occurs as a result of the retraction and it is not independent of it.

According to Ladefoged (1982), "it is only recently that phoneticians have realized that the epiglottis should be considered the active articulator in the production of pharyngeal sounds" (p. 149). The same proposal is given in a number of studies such a Laufer and Baer (1988), Butcher and Ahmed (1987) and Laufer (1996). Laufer and Baer used a flexible fiberoptic endoscope which was inserted at about the level of rest position of the uvula with Arabic and Hebrew speakers. It was found that "for pharyngeals, there is a tight constriction at the epiglottis, consistent with its roles as the primary articulator of these sounds" (p. 194). Butcher and Ahmed, who also worked on Hebrew and Arabic pharyngeals using spectrographic, oscillographic and pneumotachographic studies, state that it is the epiglottis rather than the tongue dorsum (back) which is responsible for the articulation of pharyngeals. But they do not seem to have used physiological equipment (as done by Laufer and Baer) to support their claims. Laufer (1996) and Laufer and Condax (1981) found that the pharyngeals are made by the epiglottis which tilts backwards towards the rear wall of the pharynx.

Laradi (1983) tends to agree that the epiglottis is the true articulator of pharyngeals, based on her thorough experimental study of Libyan (Tripoli) Arabic. She agrees that the constriction is made between the epiglottis and the posterior pharyngeal wall so that the opening is between the epiglottis and the pharynx and not the tongue root and the pharynx. She further cites Laufer and Condax (1981) who say that /ʕ/ and /ħ/ should be called epiglotto-pharyngeal, but states that but because as far as we are aware the epiglottis is the only articulator found in the pharynx, we will continue to refer to these sounds as pharyngeals. However, Laradi also argues that the role of the tongue root in pharyngeal articulation should not be totally ignored because X-ray pictures show clearly that it moves far back in the pharynx. A similar view is held by McCarthy (1994) who thinks that both the tongue root and the epiglottis are both used. For further detail on pharyngeal articulation and the anatomy of the pharynx see Laradi (1983).

The above lines summarized some physiological findings about the articulation of /ʕ/ and /ħ/ and the role of the epiglottis and/or the tongue root in their production. Consider Fig. (3) below (adapted from Ladefoged 1982). The key points are that we have a good idea where the pharyngeals are produced whereas the early scholars did not because they had no modern equipment. But 'middle of pharynx' in *tajwid* tradition is close enough for an impressionistic description.

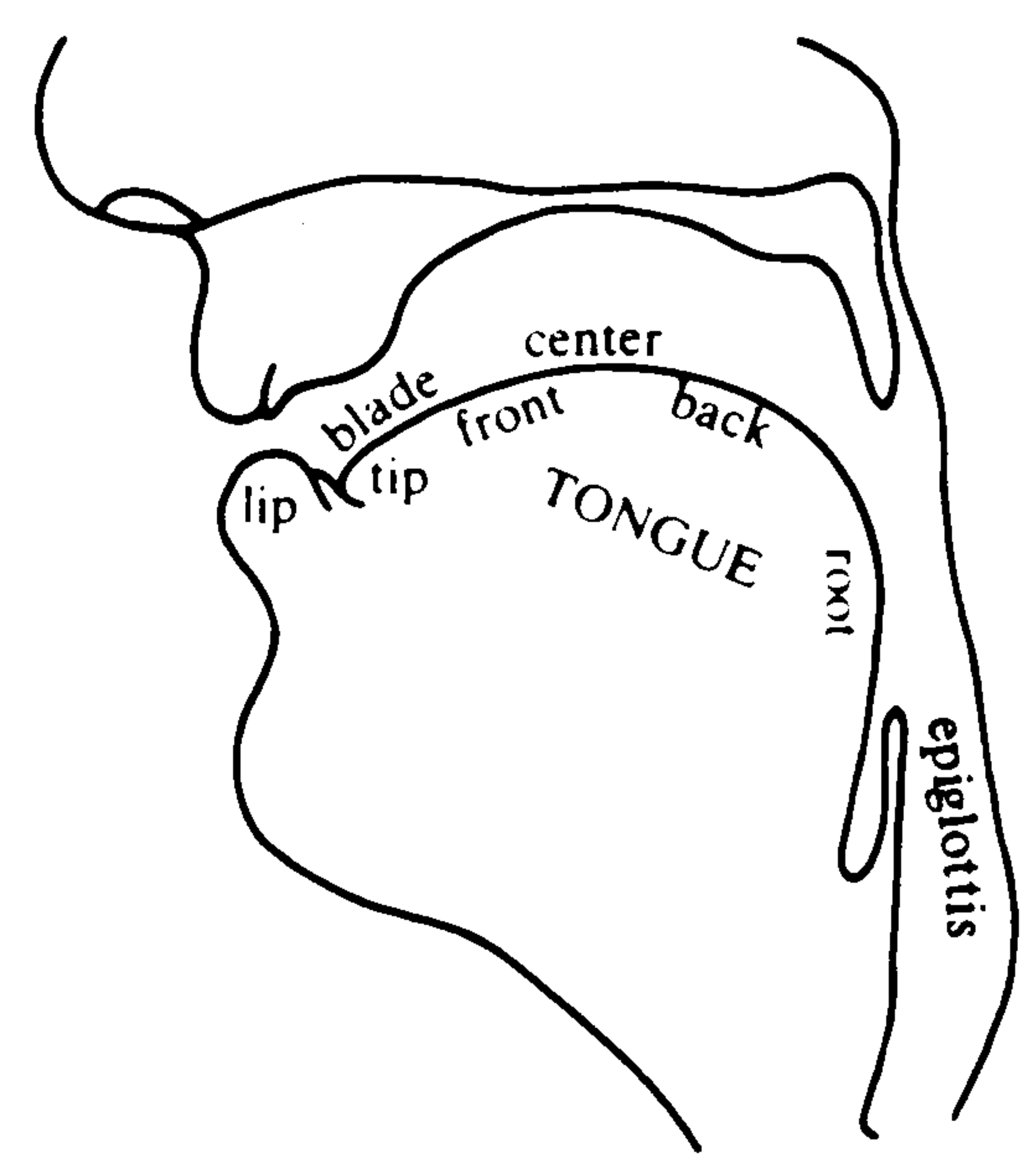

Fig. (3): The position of the epiglottis in the vocal tract
(Adapted from Ladefoged 1982 with some modifications)

The second point to consider is the traditional assumption that /ʕ/ has a lower point of articulation than /ħ/. It does not seem that this point has received the attention of modern phoneticians who are rather interested in the organs involved in the production of pharyngeals (and also in their manners of articulation). Ibn Sina (cited in Al-Ani 1994) states that /ʕ/ is produced where vomiting takes place, deep in the the throat, whereas /ħ/ is produced at the point where the speaker usually clears his throat. This naturally makes /ʕ/ produced deeper in the pharynx. Actually, the native speaker of Arabic may get the impression that is deeper in the pharynx than /ħ/ particularly if he pays attention to the way he articulates them. But the points of articulation the two sounds could also vary depending on the degree of pharyngeal narrowing and muscular tension and that could, in turn, give the speaker the impression that /ħ/ is deeper in the pharynx than /ʕ/.

In a cinefluorographic study of Moroccan speakers Dkhissi (1983 cited in Butcher and Ahmed) found that for /ʕ/ the constriction is somewhat narrower and slightly lower in the pharynx that for /ħ/. By contrast, El-Halees (1985: 288) reports that in Iraqi Arabic "the constriction for the voiceless pharyngeal /ħ/ is lower and narrower than for /ʕ/" (p. 288). We can clearly see that the two phoneticians do not agree and that they are somehow correlating between the degree of pharyngeal constriction and the point at which the pharyngeal consonant is produced in the dialect he studied. In other words, the narrower the constriction the lower the point of articulation. The difference could be dialectal or it could be the result of a special articulatory effort by the speaker. If it is a dialectal difference, then we can assume that Iraqi pharyngeals are more similar to the pharyngeals of CA than those of Moroccan. But we have to bear in mind that the differences in the point of articulation of pharyngeals in various styles may not be as variable as it might appear. Laufer and Baer (1988) for example found that because the pharynx is highly constricted for the production of pharyngeals the range of variation in the degree of constriction is relatively small. That could be one reason why Arabic dialects do not show significant differences among the allophones of the pharyngeals unlike what can be generally observed with other segments.

The position of the hyoid bone and the distance between it and the lower jaw are consistent with the traditional approach which considers /ʕ/ to have lower point of articulation that the one of /ħ/. Ghali (1989: 41) reports that X-ray pictures indicate that the distance between the highest point of the hyoid bone and the mandible (lower jaw) is 9 mm for /ʕ/ and 7 mm for /ħ/. But it is not quite clear how to quantify the distance between the points of articulation of the two sounds especially when we come to assume that the epiglottis is the primary articulator of pharyngeals as shown in a number of studies whereas the movements of hyoid bone are most unpredictable and do not follow a particular pattern (Ghazeli 1977). Further, since the lower jaw is also likely to be involved its role in pharyngeal articulation is worth of investigation. For example, Lee (1994) conducted a cross-linguistic study of the role of the jaw in consonant articulation in Arabic, French and Korean using a splint which was attached to the lower teeth of each of his subjects along with audio-visual techniques. He made the conclusion that the jaw always lowers from its position in adjacent vowels in pharyngeals for most speakers, which provides evidence against Goldstein's hypothesis (1991) that the jaw does not participate in the production of pharyngeals.

The uvulars /χ/ and /ʁ/ are the last two consonants that constitute the pharyngeal group of sounds. In *tajwid* tradition, it is argued that both sounds are produced at the front/top of the pharynx (*adnā al-ḥalq*) which is the part nearest the mouth (Al-Qāri' 1984) or nearest the tongue (Maᶜbad 1989). Two problems arise with these sounds: (i) the claim that they are pharyngeal and (ii) the controversy about their point of articulation in relation to the one of /q/ which is also apparently a uvular sound. The traditional claim that /χ/ and /ʁ/ are pharyngeal is confusing because their primary articulation involves the back of the tongue and the uvula, as stated, for example, by Ladefoged (1982). According to Sibawayh (cited in Abu Shaᶜar 1996), the point of the articulation of both sounds is the area which is nearest the tongue (note that he is referring to the back of the tongue). He also says that the two sounds are produced half the distance between the mouth zone (i.e. the oral cavity) and the pharyngeal zone. But he does not explicitly determine a particular point of articulation other than the top of the pharynx or nominate the articulators involved in the production of the two sounds. In other words, Sibawayh could be referring to the general area where the friction is made at the back of the mouth, i.e. the place of articulation. But this interpretation does not entirely solve the problem of why the two uvular sounds are described as pharyngeal in *tajwid.*

Actually, the problem raised above could be terminological. Al-Nassir (1993) suggests that the boundary between the pharynx and the velum is not clear in tradition. He says that "it cannot be ascertained whether the velum was considered part of the *ḥalq* 'the pharynx', overlapped with it, or bordered on it" (p. 14). Anis (cited in Al-Ghuraybi 1986) says that if the meaning of the term 'pharynx' in tradition is equivalent to the modern conception of the pharynx there is no doubt that the early scholars were mistaken in stating that the two sounds are articulated in the pharynx. But if the term covers the back of the tongue region and the uvula then the problem can be resolved. Indeed, Al-Ghuraybi (1986: 39) thinks that the traditional term is so broad that it covers the larynx and the soft palate including the uvula. That is basically why the glottal stop is considered a pharyngeal sound as well. It is possible to assume that the pharynx in *tajwid* covers the larynx, epiglottis and the soft palate. Thus, if we hypothesize that the uvula (and in fact the rest of the soft palate) belongs to the pharynx according to tradition then we can see why the point of articulation of /χ/ and /ʁ/ is regarded the pharynx not the uvula.

2.3.1.3 The tongue (*al-lisān*)

The tongue is the organ directly responsible for the production of 18 segment types most of which are articulated in the anterior region of the oral cavity. We will discuss below the points of articulation of these sounds.

(i) The back of the tongue

Sibawayh (cited in Al-Nassir 1993: 14-5) states that /q/ is produced "from the farthest end of the. tongue and the part of the mouth roof above it". Thus, two articulators are mentioned, one active and one passive. The passive articulator is mostly the uvula. A similar description is given by Ibn Jinni (cited in Bakalla 1982) who states that from above the point of articulation of /χ/ and /ʁ/ in the lower back of the tongue (*aqṣā al-lisān*) against the part of the palate lying opposite it there is the point of articulation of /q/. Bakalla suggests that Ibn Jinni is referring to the uvular region and that /q/ differs from /χ/ and /ʁ/ because the last two sounds are produced at the post-uvular region, i.e. further back in the oral cavity. Sibawayh does not mention the uvula in his description of /q/ (nor /χ/ and /ʁ/). Abu-Sha^{c}ar (1996) says that the reason could be the difficulty of drawing a clear boundary between the uvula and the soft palate. ^{c}Umar (1991) similarly states that although it is quite possible to distinguish between the hard palate and the soft palate it is difficult to decide on the exact point that separates between them, and the same problem would apply to the soft palate and the uvula.

Sibawayh and his followers distinguish between /q/ and /k/ by placing the point of articulation of /k/ just in front of /q/: and argue that the former is produced "from a place slightly lower (i.e. more anterior) than the place of /q/ on the tongue and the part of the mouth roof above it" (Al-Nassir 1993: 14-5). In other words, the two sounds are not produced at the same point since /q/ is uvular while /k/ is velar. It was stated above that the early scholars do not adopt special terms to distinguish between the uvula and the soft palate and call them both *al-ḥanak al-a^{c}lā* 'the upper palate'. Consequently, if a group of sounds are produced from close points of articulation, and in order to be more specific, the *tajwid* scholars describe those sounds in terms of the distance that separates them to keep them distinct. For example, it was stated that /ʕ/ is produced at a lower point than /ħ/. That could be one example where the scholars use one particular sound as a reference to the description of the point of articulation of another sound. Such an approach is, indeed, characteristic of *tajwid* and it becomes essential when a number of sounds are produced from the same general place of articulation especially the tongue. Thus, narrow descriptions that denote exact location such as 'slightly lower', 'closer to' and 'deeper' are commonly adopted in the literature. These descriptions to some extent solve the terminological problem of which part of the vocal tract is being referred to when scholars describe points of articulation of similar sounds.

(ii) The middle of the tongue

Sibawayh (cited in Abu-Sha^{c}ar 1996: 65) says that the three consonants /dʒ, ʃ/ and /j/ are articulated "between the middle part of the tongue and the middle part of the upper palate". The early scholars agreed about the place where these sounds are articulated in the vocal tract, but they did not agree on their exact order. In other words, the exact point of articulation of each of the three palatal consonants is controversial.

Al-Nassir (1993) reports that Sibawayh arranges the above sounds in the same sequence he follows when ordering the Arabic alphabet. Could that imply that Sibawayh meant that the articulation of /j/, for example, involves a point of articulation which is farther back in the oral cavity than the one of /ʃ/ and that /dʒ/ is the most anterior among the palatal consonants? The answer is not clear. Clearly, one should avoid basing phonetic judgements on orthography and the order of the alphabet. Yet it is also possible that some early scholars thought that the difference between the points of articulation of the three sounds is small or that there is no significant difference at all between their points of articulation.

(iii) The edge of the tongue

Al-Dāni (cited in Abu-Sha^{c}ar 1996: 67) states that "the edge (i.e. side) of the tongue has two outlets for two consonants: /ḍ/ and /l/". There appears to be no significant problem with the early descriptions of the point of the articulation of /l/, which is known as an alveolar lateral consonant in modern literature. Sibawayh (cited in Abu-Sha^c^ar 1996) is very specific when he describes the point of articulation of this sound. He says that is produced from the edge of the tongue from its nearer part till the end of its tip, and the part of the upper palate which lies next to it, just above the bicuspid *(al-ḍāhik)*, canine *(al-nāb)*, lateral incisors *(al-rubā^c^iyyah)* and front/central incisors *(al-thaniyyah)*. Descriptions similar to those of Sibawayh's we found in modern phonetic literature. For example, O'Connor (1973) says that for the production of /l/ the tongue tip is raised against the alveolar ridge while the sides of the tongue are not in contact with the sides of the palate along all their length so that the airstream is free to pass over the tongue, round the alveolar obstruction. The main difference between some old and modern descriptions lies in the amount of detail given by people like Sibawayh as regards the points at which the lingual contact is made between the side the tongue blade and the alveolar ridge. But it could also be argued that the point of articulation of /l/ is not so broad to cover all the areas identified by Sibawayh and that the true area of lingual contact can hardly exceed the front incisors. According to Al-Dāni, (cited in Al-Qāri' 1984) it is quite to possible to articulate /l/ by pressing the tongue tip against the part of the alveolar ridge which lies behind the front incisors, but since the reciter usually spreads the side of the tongue because this sound has lateral characteristics it is sometimes thought that the point of articulation covers all the areas that extend from the front incisors to the bicuspid. In other words, he disagrees with Sibawayh. On the other hand, Al-Khalil (cited in Al-Nassir 1993) prefers to call /l/ *dhalaqiyyah* 'apical' on the basis that the tongue apex (tip) is involved in its articulation. But we are not sure whether he considers the possible points of contact between the tongue blade and the upper palate or he rather focuses on the tongue tip and the central incisors.

Abu-Sha^{c}ar (1996) carried out an electropalatographic (EPG) study of a number of /l/ sounds and found that Sibawayh was absolutely correct when he said that the lingual contact extends to the bicuspid. However, Abu-Sha^{c}ar's data show clearly that the lingual contact can extend as far back as the molars. That makes the question of the exact points involved in the production of /l/ subject to further investigation. It might be possible that the tongue blade occasionally makes an accidental lingual contact further back on both sides of the palate as a result of the raising of the tongue body whereas the principal contact is reserved for the very anterior part of the alveolar ridge. It might also be possible that people differ in the way and extent to which they make the lingual contact but the difference is not linguistically important.

The second sound whose production involves the edge of the tongue is /ḍ/, which is a problematic sound. According to Al-Wohaibi (1982), "/ḍ/ is the most debated sound in Arabic. Surprisingly, the description provided by the *qurrā'* (i.e. reciters) and grammarians is straight and clear, notwithstanding its conciseness. Yet the controversy seems almost endless" (p. 128).

Two problems arise with classical /ḍ/: (i) the way it is described in tradition and (ii) the way it is actually articulated. The way the point of articulation of this sound is described in the relevant literature may sound confusing particularly to the modern phonetician. The confusion is the result of the traditional description which states that /ḍ/ is not an alveolar consonant but rather lateral. Sibawayh (cited in Semaan 1968:

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The descriptions presented so far imply that the early Arabs produced a laterally released interdental stop; a sound whose point of articulation is not familiar to the modern phonetician and whose articulation could be extremely difficult. The existence of this sound in the past is mentioned in sources other than *tajwid.* For example, Holes (1994) states that /ḍ/ historically was a voiced emphasized dental plosive with a lateral release and that the lateral release has been lost from modern Arabic styles. In his study of Semitic Leslau (1957) reached the conclusion that there existed an interdental lateral /ḍ/ in the Proto-Semitic phonetic system, but he could not decide whether it was voiced or voiceless. He further hypothesizes that the ancient sounds must have been affected in their historical evolution and that the interdentals, laryngeals and laterals, in particular, underwent more phonetic changes than some other sounds. He finally concludes that "the precise mode of articulation of most of the sounds in Proto-Semitic is unknown" (p. 327). But he assumes that a lateral /ḍ/ is still recognized in modern Arabic dialects although it has undergone phonetic changes so that it come to be pronounced today as retroflex stop or an alveolar stop. The significance of Leslau's study as far as we are concerned here is that it provides additional evidence that the phonemic inventory of CA could have contained the sort of sound described by the early *tajwid* scholars as a lateral /ḍ/. However, we should also consider that the details of the articulation of this sound hardly exist in sources other than the *tajwid* literature itself and that makes it difficult for us to seek precise information about this sound.

Does a lateral /ḍ/ exist in CA today? Al-Wohaibi (1982) says that according to his information this sound is produced by a few reciters and that many others "cling to the emphatic [ḍ] which we have named Egyptian *ḍād* " (p. 131).[10] In other words, not all the contemporary expert reciters are able to produce the original classical /ḍ/ and some of them replace it by a modern dialectal allophone which rather has an alveolar point of articulation. It might be that this modern allophone has retained some of the articulatory and/or auditory qualities of the original segment so that when both sounds are articulated the ordinary listener can not observe the difference.

We think that the questions of how classical /ḍ/ is actually produced would be better tackled experimentally. EPG studies, for example, could determine whether the lingual contact on the sides of the palate is primary or merely accidental, with the principal lingual contact some where else. It would also be worth investigating the similarities between /ḍ/ and /l/ on the basis that they both are regarded as lateral. If these issues were investigated experimentally, it could help settle the controversy about the existence of this sound.

(iv) The tip of the tongue

The sounds produced with the tip of the tongue comprise the largest group among the tongue sounds. There are 11 of them: /ṭ, t, d, ð̣, ð, θ, ṣ, z, s, n/ and /r/. The majority of these sounds occur in a number of languages and not only in Arabic. The sounds articulated by the tongue tip fall into five categories according to their points of articulation:

[10] *Ḍād* is the name of the letter. Al-Wohaibi (1982) should make it clear whether classical /ḍ/ is emphatic or non-emphatic. His statement "cling to the emphatic [ḍ]" is confusing because it could be

(i) Between the tongue tip and the root or the base of the upper incisors: /ṭ, t/ and /d/. These sounds are occasionally referred to as the apico-alveolar class in modern phonetics (Bakalla 1982).

(ii) Between the tongue tip and the edges of the upper incisors: /ð̣, ð/ and /θ/. These are called interdentals in modern terms (Bakalla 1982).

(iii) From the gap between the tongue tip and the front incisors: /ṣ, z/ and /s/. These sounds are called lamino-alveolar fricatives.

(iv) Between the tongue tip and the upper incisors at a point that is slightly above is the point of articulation of /n/ whose articulation is further made through the nasal cavity. We will call /n/ an alveolar nasal as in modern phonetics.

(v) Between the tongue tip and the upper incisors like /n/ but it is slightly moved towards the blade of the tongue is the point of articulation of /r/ which is an alveolar trill.

The taxonomy of the first three groups of consonants implies that the members of each group share the same point of articulation. However, it seems that this approach is not totally acceptable to all scholars. For example, Al-Mar^{c}ashi (cited in Abu-Sha^{c}ar 1996) says that /ṭ/ comes first, then /d/ and finally /t/. In other words, /ṭ/ is more anterior than the other two sounds and the point of articulation of /t/ is the closest to the hard palate. The distance between the three points of articulation is very small. However, this is apparently an impressionistic judgement that is subject to empirical evaluation. If it is true that the three apico-alveolars have slightly different points of

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taken to mean that the classical sound was non-emphatic.

articulation it might also be possible that these points are interchangeable so that /ṭ/, for example, can be produced exactly where /d/ is produced or they may all share the same point of articulation. The same assumptions could also apply to the interdentals.

There are interesting problems concerning the three sibilants /ṣ, z/ and /s/. Ibn Jinni's description of the point of articulation of these sounds is not specific enough. Bakalla (1982) suggests that not only the tongue tip is used but also the tongue blade. So, he extends the meaning of *ṭaraf al-lisān* 'the tip of the tongue' to include a small part of the blade of the tongue. Bakalla also hints that he thinks the three sounds have a lamino-alveolar point of articulation. He cites Al-Saᶜran (1951) who says that in articulating these sounds, the tip of the tongue is raised towards the teeth-ridge for some speakers and for others it is not raised at all. In other words, it is possible that some speakers retain the tongue body almost flat in the mouth whereas some others raise it towards the alveolar ridge when they pronounce these sounds. We observe that both El-Saᶜran and Bakalla are interested in whether the tongue tip is raised or not. That could imply that the tongue blade could be more crucial to the articulation of the sibilants and/or that a significant mechanism is not clearly defined in traditional texts.

Although it is not clear whether El-Saᶜran (1951) based his conclusion on physiological studies of the tongue activities during the articulation of the sibilants, he indirectly sheds light on the role of the lower teeth (more specifically the incisors) and the lower jaw in the production of the sibilants. According to Bakalla, Ibn Jinni does not explicitly mention organs other than the upper incisors and the tongue tip. Sibawayh (cited in Abu-Shaᶜar 1996), however, indicates that the sibilants are released from the gap between the incisors. So, it could be argued that he is more accurate. In fact, Al-Khalil is even more specific than Sibawayh because he mentions that the active articulator is the pointed end of the tongue tip (Al-Nassir 1993).

The remaining sounds of the tongue tip group are /n/ and /r/. Both sounds are alveolar in modern terms. According to Abu-Sha^{c}ar (1996), some early scholars (probably following Al-Khalil) state that /n/, /r/ and /l/ share the same point of articulation. But the majority of scholars prefer to follow Sibawayh who attributes each sound to a separate outlet and states that /n/ is further produced through the nasal cavity which clearly implies that the early scholars could observe the role of the velum in the production of nasality. But it seems that the question of whether /r/ has a point of articulation further back than the one of /n/ or the other way round is still controversial in *tajwid* tradition. Presumably, one of the factors that leads to the controversy is that it is quite possible to articulate sounds like /n/ or /r/ on more than a single point on the alveolar ridge.

2.3.1.4 The lips (*al-shafatān*)

There seems to be no problem which is worthy of investigation with the labials: the labiodental /f/ and the three bilabials /w, b/ and /m/. The point of articulation of /f/ is described by Sibawayh as the inner side of the lower lip against the upper incisors (Al-Nassir 1993). However, Al-Mar^{c}ashi (cited in Abu-Sha^{c}ar 1996) states that the lingual contact is also made with the lateral incisors and the canines. Although what the Al-Mar^{c}ashi says could be true as far as the lingual contact is concerned it should also be noted that the airstream flow is quite restricted in a narrow zone which hardly extends any further beyond the upper front incisors. In other words, there is no significant problem with Sibawayh's description of /f/. The three consonants /b, m/ and /w/ are bilabial, a description which is quite common in modern phonetics.

2.3.1.5 The nasal cavity *(al-khayshūm)*

The nasal cavity is considered a place of articulation by some scholars because the airstream goes through it when producing nasals, nasal assimilation and extended nasality (see section 2.2.3). Nasality is described as a nasalized sound for whose production the tongue plays no articulatory role (Al-Ansari 1991: 37). This definition reflects the scholars' emphasis on the tongue which, in spite of being the active articulator of the majority of sounds, plays no role in nasality. It may also draw the learner's attention to the mechanism that occurs in the back of the oral cavity, namely the lowering of the velum when producing nasality.

Fig. (4) below (Al-Sakkāki, d. 1228) illustrates the main points raised so far as regards the points of articulation of CA segments. The pharynx is indicated at the left side and the lips at the right side with the relevant sounds distributed on the appropriate outlets. The teeth are given for their names so that the reader can see clearly where certain sounds are to be produced. The nasal cavity (dotted line) appears at the top. According to Bakalla (1994), this is apparently the earliest ever recorded diagram of the speech organs and points of articuladtion.

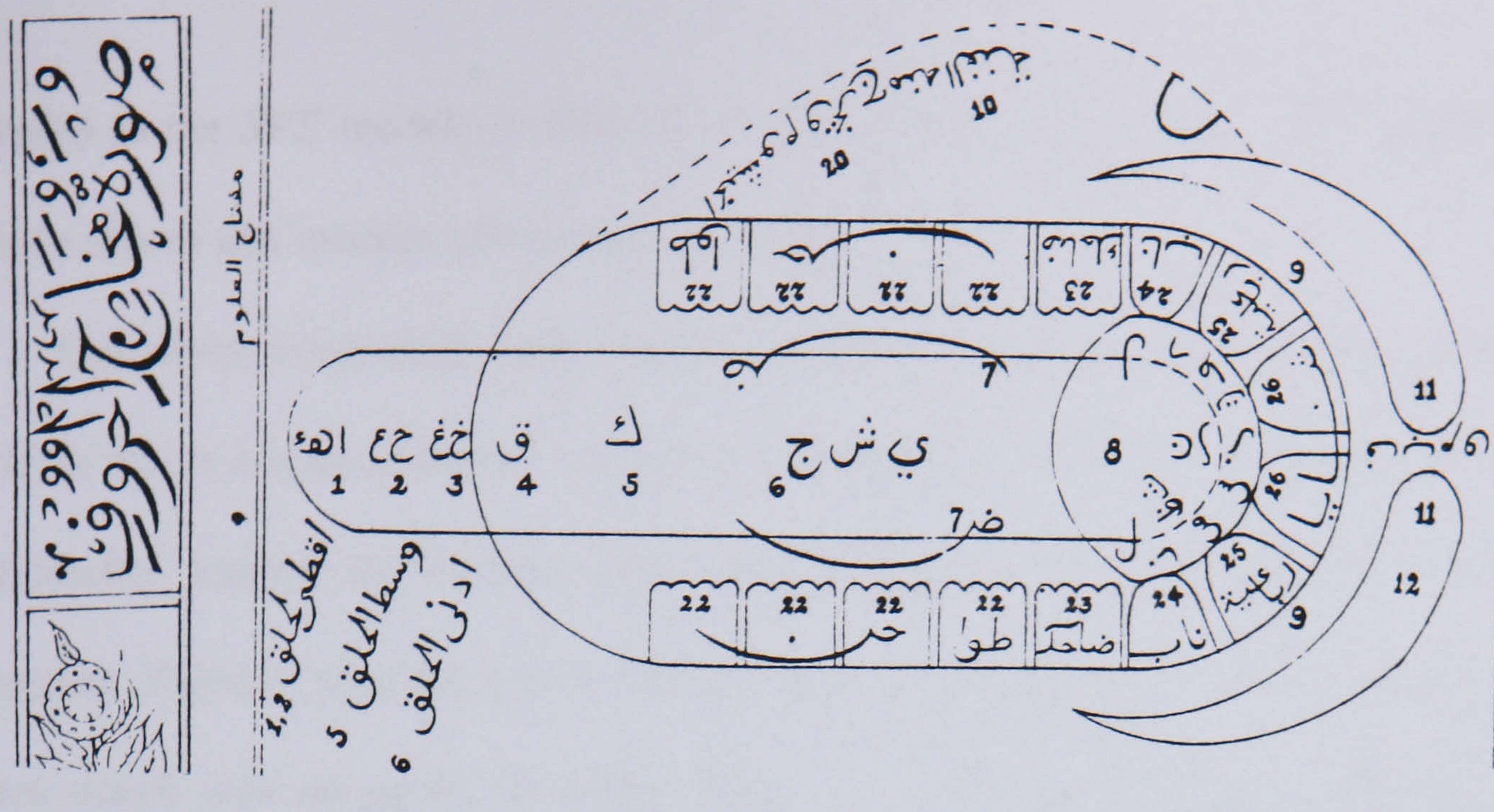

Fig. (4): An early Arabic illustration of the vocal organs. (Main source: *Miftāḥ Al-ᶜUlūm*, (Key to Arabic Sciences), by Yūsuf Al-Sakkāki (d. 1228); reproduced here from *Encyclopedia of Language and Linguistics*

Key (note: numbers added in modern times and those skipped refer to vocal structures not represented in this figure): 1: vocal cords, 2: larynx, 3: epiglottis, 4: root of the tongue, 5: pharynx, 6: uvula, 7: palate, 8 hard palate, 9: alveolae, 10: nose, 11: lips: 12: lower lip, 20: nasal cavity, 22: molar, 23: bicuspids, 24: canines, 25: lateral incisors, 26: central incisors.

2.3.2 Manners of articulation of CA segments *(ṣifāt al-ḥurūf)*

The aim of this section is to discuss the manners of articulation of CA segments in *tajwid* tradition. We will attempt to see how *tajwid* treats manner features with a special consideration of the phonetics of Arabic as it is conceived by Sibawayh (d. 809) and his followers. A number of issues, some of which are still debatable, will be discussed below such as the precise meaning of certain features, the relation between features and the morphology, the status of vowels in the feature system and the classification of features into binary and unary, on the one hand, and strong and weak, on the other. Since our intention in this section is to look at *tajwid* from a modern perspective we will be referring to modern features (mostly the ones presented in the *SPE* model) in order to see some of the similarities and differences between *tajwid* and modern phonology/phonetics.

One of the interesting aspects of traditional Arabic phonology, including that of *tajwid*, is that it adopts a feature analysis and classifies features into binary and unary (traditionally known as features that have opposites and features that have no opposites). *Tajwid* scholars seem to have generally agreed on a particular feature system which was set up by the early Arabic grammarian Sibawayh. Bohas *et al* (1990) state that such a system was originally elaborated by Sibawayh and was re-used without modification by subsequent grammarians. According to Bakalla (1994), "as a phonetician and grammarian, Sibawayh employed his phonetic analysis in order to explain the intricate morphophonemic changes, rules of assimilation, dissimilation, substitution, and mutation, deletion, metathesis, and phonotactics" (p. 189). Osman (1988) argues that by looking closely into Sibawayh's ideas one can get the impression that this scholar was completely aware of the role of distinctive features in the phonological structure of Arabic. When *tajwid* became an independent discipline in the 10th century (see Chapter One) scholars started to appreciate the significance of the theory of distinctive features for the teaching of correct recitation to both native and non-native speakers.

Al-Hamad (1989) points out that both Makki (d. 1017) and Al-Dāni (d. 1024) played a very essential role in the formalization and codification of features. Makki identified 44 features. Some of these which are place features that indicate the place of articulation of segments such as the pharynx, palate and alveolar ridge. Other features adopted by Makki are relevant to the morphological system of the language and have no phonetic value. The contribution of Makki was criticized by some of his contemporaries who thought that there was no practical need for such a relatively large number of features most of which were redundant or predictable. For example, Al-Mar^{c}ashi (cited in Al-Hamad 1986: 229) selected 18 features out of the feature system of Makki assuming the reciter does not need the others. When Al-Dani studied the features of CA he decided to limit them to 16 features most of which will covered below. The majority of scholars adopted the approach of Al-Dāni. But some of them such as Al-^{c}Aṭṭār (d. 1149), Ibn Al-Ṯaḥḥān (d. 1160) and Ibn Al-Jazari (d. 1429), introduced some modifications by excluding certain features and replacing them by some others. The successive modifications in the feature framework since Sibawayh gave rise to several improvements to both the phonological and phonetic analysis of CA.

Manner features in *tajwid* do not only describe the manners of articulation of each segment "but also a number of general properties, partly articulatory and partly auditory, which are supposed to organize all the segments into families of sounds" (Bohas *et al* 1990: 94). Makki (cited in Abu Sha^{c}ar 1996: 88) states that "without the differences between the features of consonants the listener will not distinguish between the consonants that are produced from the same outlet. And without the difference between the outlets it is not possible to distinguish between two consonants or a group of consonants that share the same feature". Makki further argues that sounds will vary considerably from each other if they are articulated from different places of articulations and if they have different features. But if consonants share the same features they tend to become similar even though they may be produced from different points of articulations. But he also draws a distinction between consonants as regard the number of features they can share stating that consonants can share some features only and it is not possible to find consonants that share exactly the same set of features and the same point of articulation otherwise all the sounds of the language will become identical.

Regardless of the number of distinctive features which may vary from one school to another in the traditional approach, Makki's work shows clearly that the feature is traditionally treated as a phonetic property that can be used to classify sounds into groups for the phonological analysis and description of CA. The assumption that segments cannot share all the features clearly implies that *tajwid* is not merely a phonetic subject which is devoted to sound production but it is also a phonological subject that treats each individual segment as part of a vocal code which consists of a group of features that are unique to it. This point sheds lights on the similarity between *tajwid* and 20th-century phonological theories of distinctive features. But it should also be pointed out that *tajwid* differs significantly from current in the sense that it is not highly devoted to theoretical sophistication. Perhaps the difference between the two phonologies is due to the fact that some early *tajwid* scholars adopted the feature system of Sibawayh and others for pedagogical purposes which, in turn, might have affected the way they tackled the feature approach in their instruction manuals. Nevertheless, we still think that they could provide useful insights into the question of the abstract level of Arabic phonology.

Following Ibn Al-Jazari, manner features fall into two categories. The first category comprises 10 binary features which can be generally defined as a system of phonological oppositions in CA. Accordingly, a segment is either specified or unspecified for a particular feature (which in current terminology carries a plus '+' or minus '-' value). The second category comprises 8 unary features whose main function, according to the *tajwid* theory, is mainly to improve the articulation of segments. Al-Hamad (1986) says that the principle of unary features was first adopted by Al-Muradi (d. 1329) and then by Al-Wafā'i (d. 1610). It is not clear whether these features were mentioned by some of their predecessors (particularly Sibawayh who was probably the first grammarian to establish the feature system). But their main use is reserved for the oral skill of recitation, they are redundant features since they are predictable and their phonemic categorization and semantic value in utterances are not affected in any significant way if the speaker does not produce them as fluently as recommended. Unary features in the *tajwid* tradition primarily have a purely phonetic function.

Although the unary features are non-distinctive there is a general agreement between *tajwid* scholars and modern phonologists about their significance within the theory of language. In *tajwid*, although the binary features are the only distinctive features that specify the contrastive values of the phonological representation of CA the unary features remain quite relevant to certain low-level phonetic phenomena. Jakobson (1951) appears to appreciate the significance of feature redundancy for one reason or the other. In Jakobson, Fant and Halle (1952), it is argued that "the role of redundancies must not be underestimated. Circumstances may even cause them to substitute for the distinctive feature" (p. 8). Anderson (1985) also says that "in numerous places Jakobson insists that a description of the redundant features as well as the distinctive ones must be included in an adequate theory of language, but he never proposed a real theory of these redundant features which was separate from the theory of distinctive features" (p.126). Regardless of whether Jakobson could actually come up with what he considered a significant approach to phonological analysis the emphasis which he puts on the need for redundant features is worthy of further investigation especially when we consider the feature system of CA. But it is not quite clear why and how a non-distinctive feature may turn into a distinctive one (or the other way round) and what kind of circumstances that can lead to such a significant modification in the grammar. It is not clear either whether changing a non-distinctive feature into a distinctive one will permit the group of features already identified for their distinctiveness to retain their grammatical function or not.

We will discuss below each feature separately starting with the binary features. Unlike convention in *tajwid* manuals, however, the first two features to start with will be those which are directly relevant to the topic of the thesis (emphasis).[11] Feature names will be enclosed between square brackets for convenience. Vowel features are discussed along with consonant features because, according to *tajwid*, some features can be shared by both categories of sounds. This point will be discussed after the features have been presented.

2.3.2.1 Binary features

(i) [*musta^{c}lī*] vs. [*mustafil*]

As we shall see in the following chapter, the feature [*musta^{c}lī*] 'elevated/raised' vs. [*mustafil*] 'low' and the feature [*muṭbaq*] 'lidded' vs. [*munfatiḥ*] 'open' are quite essential to what is traditionally known as *tafkhīm* 'grandeur' which is equivalent to

[11] Usually, *tajwid* manuals present the features [*majhūr*] 'voiced' and [*mahmūs*] 'voiceless' before other features.

conventional ‘emphasis’ in Western phonological literature. The four features refer to tongue activity in the production of segments.

The consonants specified for the feature [*musta^{c}lī*] (or [*musta^{c}liyah*]) ‘elevated/raised’ are 7: the four coronals /ṭ, ṣ, ḍ, ð̣/ and the three gutturals /q, χ, ʁ/. They share this feature because their production requires the raising of the tongue back towards the palate which is a secondary articulation with the coronals (to distinguish them from /t, s, d, ð/ as it will be indicated below) and a primary articulation with the gutturals. The remaining consonants and the vowels are [*mustafil*].

One of the problems with the feature [*musta^{c}lī*] is the way it is defined in the literature. For example, Ibn Al-Jazari (d. 1429) states that elevation is a strong feature (see section 2.4.2.4 below) but he does not define the feature itself. Al-Dāni (d. 1052) states that the sounds specified for [*musta^{c}lī*] are produced with the tongue raised towards the palate. Therefore, his description appears to be more accurate. Ibn Jinni (cited in Bakalla 1982) assumes that /q/ is a high-tongue sound whereas /s/ is a low-tongue sound. Both Al-Dani and Ibn Jinni indicate that the tongue is raised towards the palate but neither of them clearly indicate the portion of the tongue raised (front, mid or back) nor the part of the palate which acts as the passive articulator in the production of the elevated sounds. The same problem can be realized in some modern works on *tajwid* (e.g. Ma^{c}bad 1989) while some others (e.g. Naṣr 1992) attempt to define the feature more precisely. The early scholars are probably referring to the raising of the back of the tongue whether the rest of the tongue is raised or not. This conclusion is based on the observation that all the sounds produced by the middle and front of the tongue in addition to velar /k/ are not regarded *musta^{c}liyah* which clearly implies that the tongue back is seen the articulator. But since the production of /k/ as a velar consonant also involves the tongue back Al-Mar^{c}ashi (cited in Abu-sha^{c}ar 1996) draws a further distinction between /k/ and the elevated consonants stating that 'elevated' because the part of the tongue raised for this sound is located between the back and middle. To avoid confusion, however, we think that it is more appropriate to define the feature [*musta^{c}lī*] in terms of the raising of the extreme or lower back of the tongue so that it would be clear that velar /k/ does not constitute a natural class with the other seven consonants on the basis that the lingual contact is closer to the middle of the tongue.

We will discuss some of the modern features which correspond with the elevated consonants in greater detail in Chapter Three. Meanwhile, the question whether the cavity features [high] vs. [low] in *SPE* are appropriate equivalents to [*musta^{c}lī*] and [*mustafil*] is worth discussing. Al-Nassir (1993) decides that [high] and [low] are appropriate but he gives no clear line of reasoning. Bakalla (see above) translates the two traditional feature names into 'high tongue' and 'low tongue' and Al-Wohaibi (1982) similarly uses 'high' and 'low'. However, among the three only Al-Nassir clearly adopts the view that the *musta^{c}liyah* consonants could be given the phonetic feature [+high] and the *mustafilah* [-high] or [+low].

According to the *SPE* model of feature system set up by Chomsky and Halle (1968), a high sound is made by raising the body of the tongue above the level it occupies in the neutral position while a non-high (low) sound is made without raising the tongue body.[12] Spencer (1996) states that "the palatals, velars, palatalized, velarized consonants, together with the high vowels and glides, are all [+high]; other sounds are [-high]" (p. 143). In other words, the traditional and modern features are by no means identical for a number of reasons. In *SPE*, [high] can be associated with velars while traditional [*musta^{c}lī*] excludes them. The former feature also covers palatals and palatalized consonants while the latter rules them out. The status of [-high] is similarly problematic. For example, McCarthy (1994) argues that since the Arabic uvulars are actually produced with a high tongue body (which can generally be observed impressionistically) there seems to be good reason to reject it not only because it is inconsistent with the articulatory properties of the uvulars but also because it presents major difficulties in the context of feature as a whole. That all implies that [high] differs significantly from traditional [*musta^{c}lī*].

(ii) [*muṭbaq*] vs. [*munfatiḥ*]

The feature [*mutbaq*] 'lidded' refers to the raising of both the tip/front and back of the tongue in the production of the front emphatic coronals /ṭ, ṣ, ð, ḍ/ which are accordingly characterized by multiple articulation the secondary of which underlies the phonemic contrast between these sounds their plain counterparts. All the remaining sounds, including the vowels are [*munfatiḥ*] 'open'. According to tradition, the tongue assumes a hollow shape and the palate looks like a cover or lid which is placed against

[12] Chomsky and Halle define the neutral position as that of the vowel [ɛ] as in 'head'. According to Ladefoged (1982) most phoneticians disagree with this definition and consider the neutral position of the tongue to be more that of [ə] as in 'about'.

the top of a pot so that the sound is trapped in such a way that makes it distinct from sounds from other classes. According to Sibawayh (cited in Al-Nassir 1993: 50), "in these four consonants (i.e. /ṭ, ṣ, ð̣, ḍ/) if you apply your tongue in their place (of articulation) it will close on from their primary places up to the part of the tongue opposite to the velum, towards which you raise your tongue. Applying the tongue this way the sound will be enclosed between the tongue and the velum on one side and the places of the sounds on the other side". Sibawayh points to the phonological opposition between the emphatic coronals and their plain counterparts by stating that the tongue back raising toward the velum is crucial to the distinction because without it /ṭ/ would turn into /t/, /ṣ/ into /s/, /ð̣/ into /ð/ and /ḍ/ would not exist anymore in speech.[13]

Although the early scholars do not explicitly mention multiple articulations their descriptions of *iṭbāq* 'lidding' imply they are aware of them. But it does not seem that they make reference to a specific point of articulation on the passive articulator which is the upper palate, or distinguish the soft palate from the hard palate. Nevertheless, some linguists (e.g. Al-Nassir 1993, Bakalla 1982 and Jarrah 1993) equate traditional *iṭbāq* with modern 'velarization'. One of the factors that probably support their decision is the *tajwid* view which says that the tongue back is raised toward the opposite part of the upper palate and it is unlikely that some organ other than the soft palate is meant here.

[13] Such a statement implies that, from the point of view of Sibawayh, the point of articulation of /ḍ/ in CA is not the alveolar ridge because modern alveolar /d/ does have a plain alveolar counterpart which is /d/. We return to this problem in section 2.4.1.3: (iii) the edge of the tongue.

According to Osman (1988), Bakalla (1982) and Hussain (1986), the feature [*muṭbaq*] means 'covered'. There seems to exist no significant difference between 'lidded' and 'covered' since both adjectives denote similar meaning. The problem, however, is that these linguists treat the velarized consonants within the framework of feature theory and use 'covered' as a distinctive feature name. According to *SPE*, covered sounds are produced with a pharynx in which the walls are narrowed and tensed and the larynx raised whereas non-covered sounds are produced without such a narrowing and tensing in the pharynx (Ladefoged 1982). The question of whether the production of the velarized consonants involves a degree of pharyngeal narrowing so that they can be marked for [covered] may not be given a clear answer because the production of these sounds is still controversial in modern phonetics as will be shown later. In addition, the use of [covered] may not be appropriate. Chomsky and Halle state that "As far as we know, this feature is restricted to vowels and is found primarily in the West African languages exhibiting vowel harmony" (p. 315). They further suggest it might be possible to use [covered] with some vowels in non-African languages such as the two rounded front vowels of Swedish [y] and [ʉ]. But they never mention consonants or refer to specific classes of consonants. Therefore, the adoption of [covered] for [*muṭbaq*] is probably not satisfactory.

(iii) [*majhūr*] vs. [*mahmūs*]

It should be clarified that the features [*majhūr*] 'loud' and [*mahmūs*] 'whispered' along with the remaining features to be discussed below are not of a direct relevance to the main topic of the present study unlike [*mustaᶜlī*] 'elevated' and [*muṭbaq*] 'lidded'. But since one the objectives of this chapter as a whole is to give the reader a general idea about the main issues of the *tajwid* theory it might be useful to shed some light on additional features without having to deal with them in depth. The most controversial features to begin with are [*majhūr*] 'loud' and [*mahmūs*] 'whispered'.

Al-Nassir (1993), Abu-Sha^{c}ar (1996) and Bohas *et al* (1990), possibly among others, all point out that the features [*majhūr*] 'loud' and [*mahmūs*] 'whispered' have been the subject of controversy in modern linguistics. According to Abu-Sha^{c}ar, the early Arab grammarian Al-Khalil (d-791) was the first to adopt these feature names which were later clarified and re-defined by Sibawayh (d.809). Al-Khalil states that *jahr* (loudness) is *ṣawt al-ṣadr* 'sound of the chest' and *hams* 'whispering' is *ṣawt al-fam* 'sound of the mouth'. Al-Nassir (1993) assumes that the 'sound of the chest' is an impressionistic auditory term which stands for the outcome of the vibrations of the vocal cords. Sibawayh states that "a *majhūr* sound is one which is fully supported in its place and the flow of breath is impeded until the support is completed and the sound flows on, whereas a *mahmūs* sound is one which is weakly supported in its place and the breath is allowed to flow with it" (p. 35). Sibawayh further states that the nasals are supported in the mouth and the nasal cavity. So, what does the word 'place' in the definition stand for and how can a sound be supported articulatorily and, more significantly, what do the two features exactly stand for?

According to Abu-Sha^{c}ar (1996), Sibawayh says that it is not possible to make a *majhūr* sound clear unless the speaker includes it the noise that comes out of the chest and goes through the throat. For /m/ and /n/ the noise is also produced from the chest and nasality goes through the nasal cavity. Like Al-Nassir (1993) and Abu-Sha^{c}ar (1996), we tend to think that the early scholars are making an implicit reference to the vibrations of the vocal cords. They might have observed the phonational function of the larynx. Those scholars, however, had no idea about the anatomy of the larynx and its cartilages including the vocal cords whose existence seems to have been first reported in the Arabic tradition by Ibn Sina (d. 1037).[14] That is why they seem to have thought that the source of the vibration (the noise) is the chest (the lungs) rather than the larynx which they merely describe as airflow passage like the nasal cavity.

A *majhūr* 'loud' sound is said to be fully supported in its place of articulation because it has two positions in the vocal tract according to the traditional interpretation of Sibawayh's definition. The first position is found in the oral and/or nasal cavity where the sound is produced by the articulators. The second position is the source of the vibrations which is the chest according to Al-Khalil and Sibawayh. We can thus paraphrase Sibaway's definition of *majhūr* by stating that it is a sound whose articulation is not completed until it is fully supported articulatorily by the vibrations of the vocal cords. On the other hand, a *mahmūs* sound is weakly supported at its place because its production, even though is achieved by the articulators involved, is not associated with the vibrations of the vocal cords. Consequently, a voiceless sound is characterized by the presence of the breath which is not obstructed in the glottis.

[14] Ibn Sina (d. 1037; better known in the West as Avicenna) lived approximately three centuries after Al-Khalil (d.791). This rules out the possibility that the latter recognized the anatomy of the larynx or mentioned the vocal cords explicitly in his writings. Both Al-Ani (1994) and Al-Nassir (1993) seem to think that Ibn Sina was the first scholar to anatomize the larynx and describe the vocal cords. But they do not come to an agreement about whether he could identify the linguistic function of the vocal cords.

If the above interpretation of the traditional definition of *jahr* and *hams* are correct then the early scholars were definitely able to identify speech sounds in terms of the state of the glottis although they had no idea about the vocal cords as such. A number of phoneticians such as Al-Nassir (1993), ᶜUmar (1991), Fayyāḍ (1989) and Al-Ghuraybi (1986) assume that the two old features correspond to modern [voiced] and [voiceless], respectively. They are inspired by the modern experimental finding that all the sounds marked for [*mahmūs*] are found to be voiceless, and that all the sounds marked for [*majhūr*] are found to be voiced, with the exception of /ʔ, q/ and / ṭ/.

The status of these three sounds in *tajwid* and modern phonetic studies gave rise to a long controversy over the meaning of the two traditional features and different proposals emerged to solve the problem. Al-Nassir (1993), for example, considers the problem of a historical nature and he says that the three sounds must have lost some of their articulatory properties over the course of time to be recognized today as voiceless. That definitely solves the entire problem and brings the controversy to an end. Jakobson (1962), however, states that "the distinction of *mahmūsah* and *majhūrah* is often erroneously interpreted as voiceless vs. voiced, while actually it means fortis vs. lenis" (519). But he unfortunately does not give a clear explanation for his claim. Since a fortis sound can be defined as one which is produced with muscular effort and breath force whereas as a lenis sound is characterized by a relatively weak degree of muscular effort and breath force Jakobson's argument could be correct. But the traditional definitions are more or less identifying the presence or absence of the vocal cords' vibrations during speech production. Even if one agrees that the scope of voicing in tradition covers the amount of muscular effort in addition to the status of the glottis or that it denotes a feature of sonority as suggested by Bakkalla (1982), the vibration of the vocal cords will remain essential to a more straightforward interpretation of the traditional features.

In order to solve the problem Abu-Sha^{c}ar (1986) argues that it should be admitted that the traditional features are appropriate equivalents to modern [voiced] and [voiceless]. But the early scholars could have decided whether a particular consonant was voiced or voiceless by considering the release of the consonant. Thus, the speaker either produces an audible vowel immediately after the consonant which will, in turn, be described as voiced (i.e. because of the vowel added) or produces a weaker audible aspiration after the consonant so that it would be realized as voiceless. In other words, Abu-Sha^{c}ar states that a consonant is traditionally regarded as voiced by considering the syllable rather than the occurrence of the consonant in isolation. This claim, however, requires further investigation because certain sounds, such as /z/, are realized phonetically as voiced regardless whether they are followed by a vowel or not.

Having dealt briefly with the above assumptions about the meaning of voicing in the *tajwid* tradition it should also be noted that voicing is not well defined in current phonological theory. The vibrations of the vocal cords are not always necessary to consider a sound voiced. In *SPE* voiced sounds are defined as those in which the vocal cords are in a position such that they will vibrate if there is an appropriate airstream. On the other hand, voiceless sounds are those in which the glottal opening is so wide that there can be no vibration. Further studies (experimental and theoretical) may shed more light on this issue.

(iv) [*shadīd*] vs. [*rikhw*]

The features [*shadīd*] 'strong' and [*rikhw*] 'loose' stand for modern [stop] and [fricative], respectively. A third category is referred to as *byna bayn* 'in between' and it covers the sounds which are made with an oral tract constriction which is less than the one required to produce friction. This category covers /l, r, m, n, j, w, ʕ/ and all the vowels. The modern feature equivalent to *byna bayn* is [approximant]. We will deal briefly with the status of /ʕ/ in relation to this taxonomy of features for its special significance to some recent experimental findings. There seems to be no problem with the remaining sounds.

In *tajwid* tradition, /ʕ/ is not treated as a stop or a fricative on the basis that its production does not involve a complete lingual closure like stops or a narrow air-passage like fricatives. This sound has been the subject of endless controversy in modern phonetic/phonological literature regarding the amount of pharyngeal narrowing that is characteristic to it. But there has been no controversy about its point of articulation in the lower pharynx. In his study of MSA as spoken in Iraq, Al-Ani (1970) excludes the possibility that /ʕ/ can be realized as a fricative and he reports that it is a stop. By contrast, Ladefoged (1971) argues that no language uses stops in the pharyngeal area stating that "most people cannot make them" (p. 41). Heffner (1950, cited in Laradi) similarly states that no stop consonant is produced by a constriction in the pharynx. In any case, native speakers could articulate this sound in different ways.

It is argued by Laufer (1996) that the traditional classification of /ʕ/ as an approximant (he ascribes the classification to Sibawayh) is accurate since it meets articulatory facts about this particular sound when pronounced in normal Hebrew and Arabic speech. Spectrograms made of 23 speakers of both languages showed that, as with other approximants, there existed no evidence for the assumption that /ʕ/ is a stop or a fricative. There only existed a raised F1 and lowered F2 and that probably indicates a certain degree of constriction in the pharynx. Laufer also used a fiberscope to find out that /ʕ/ is produced with a relatively wider constriction than /ħ/ (which is a fricative). He finally recommended that /ʕ/ would better be treated as an approximant rather than fricative in the official IPA chart of phonetic symbols and consequently in other literature of potential interest to both phoneticians and phonologists.

(v) [*dhalaqiyy*] vs. [*muṣmat*]

The feature [*dhalaqiyy*] (peripheral/light) is derived from *dhalq* 'outermost point or edge' (Da^{cc}ās 1989). It refers to the six consonants /l, n, r, f, b, m/ which are either produced by the tongue tip or by the outermost part of the lips. Therefore, it is not an appropriate equivalent to modern [apical] since the latter does not cover labials. The definition of [*muṣmat*] 'solid/quiet' may sound unfamiliar to the modern reader. According to Naṣr (1992), the remaining consonants and the vowels are specified for [*muṣmat*] because their production is characterized by heaviness and a rather slow articulation mechanism which is not observed with *mudhlaqah* 'light (sounds)'. Such an impressionistic wording is not quite clear and it probably requires more investigation so as to understand what lightness and heaviness of articulation could actually stand for.

It is also quite possible that the features [*mudhlaq*] and [*muṣmat*] are morphologically-based features as proposed, for example, by Da^{cc}as (1989), Al-Walidi (1991) and ^{c}Uthman (1981). The sounds marked for [*muṣmat*] cannot compose a stem/root independently but they must combine with one (or more) of the sounds specified for the other feature. The exceptions to this rule are loan words of a non-classical Arabic origin. Al-Walidi (1991) further claims that the insertion of *mudhlaq* sounds in the roots of words facilitates the articulation process. That is why one possible translation of [*mudhlaq*] is 'light' or 'easy'. The adoption of these features generally sheds light on the interaction between phonology and morphology in *tajwid.*

2.3.2.2 Unary features

Unary features in the *tajwid* theory are occasionally known as *ṣifāt muḥassinah* 'improving features'. Their main function is phonetic rather than phonological. Traditionally, unary features help improve recitation performance and get it as close to the recommended standard as possible. Their acquisition apparently requires some oral practice and they are thought to reflect the reciter's skill.

(i) [*ṣafirīyy*]

The three sibilants /ṣ, z, s/ are described as [*ṣafirīyy*] 'whistling' because they are produced with a sharp whistle. It is assumed by some scholars (for example Al-Anṣari 1990 and Al-Walidi 199) that /ṣ/ has more sibilance than /s/ and /z/ because it is both [*musta^{c}lī*] 'elevated', then comes /z/ which is specified for [*majhūr*] 'loud' and finally /ṣ/ which is [*mahmūsah*] 'whispered'. It is not quite clear on what basis these sounds were ranked this way. In terms of spectral energy, /z/ is clearly the least among the three sibilants. But it may be because of voicing and the fact that /z/ is marked for [*majhūr*] 'loud' that these scholars ranked them in that order. It is mainly a question of attempting to work out what some features actually refer to. It is not always possible to find out what the *tajwid* scholars actually mean by their giving certain impressionistic descriptions of classical sounds.

(ii) [*maqalqal*]

This feature may sound unfamiliar to the modern phonetician. Literally, *maqalqal* means 'agitated' or 'shaking'. It has a number of definitions such as "resonants or movement letters (i.e. sounds)" (Cachia 1973: 83), "the strong tone" (Surty 1988: 185), "a strong sound, coming up from the chest accompanied by piercing and pressure" (Gouda 1988: 161), and "vibrating the place of articulation so that a strong tone is heard" (Nelson 1980: 47).

Five sounds /b, d, ṭ, dʒ, q/ are [*muqalqal*]. But *tajwid* stipulates that they must be unvowelled in order to exhibit this (temporary) feature. It can be observed that the sounds involved are all stops. The insertion of *qalqalah* 'agitation', which is perhaps best defined by Denny (1989) as a neutral vowel, could make these sounds retain their voicing. For example, without associating [*muqalqal*] with /b/ in *al-sabt* 'Saturday' it may turn into an aspirated voiceless sound under the influence of the following /t/ as it is observed in some colloquials. Nelson (1980) hypothesizes that the function of this feature is to change the familiar prosodic and stress patterns of the utterances. This assumption however has not yet been investigated whether by traditionalists or by modern linguists in spite of its potential significance.

(iii) [*layyin*]

The feature [*layyin*] 'soft' refers to the two semi-vowels /w/ and /j/ which can be given a longer duration than the other consonants especially if the reciter pauses after producing the utterance that contains them, as in *mawt* 'death'. In this case it is possible to prolong the /w/, i.e. to keep articulating the sound until the breath completely stops as with vowels, to the measurement of six diacritics. This feature may be a suitable equivalent to the modern term 'glide'. In fact, *tajwid* scholars frequently describe vowels as segments of prolongation and softness, thus to express one aspect of similarity between vowels and glides.

(iv) [*mukarrar*]

The feature [*mukarrar*] 'repeated' refers to trilled/rolled /r/ which is articulated with "a rapid succession of taps of the tip of the tongue against the teeth-ridge" (Gairdner 1925: 21). This description will be familiar to the modern reader.

(v) [*mutafashshī*]

The feature [*mutafashshī*] 'spread' applies mainly to the voiceless fricative /ʃ/ on the basis that the airstream spreads throughout the oral cavity in its production. Al-Walidi (1991: 91) says that this sound spreads in the anterior orifice of the mouth. Ibn Al-Jazari (d. 1429) considers /ʃ/ the only consonant which is marked for this feature. However, Al-Mar^{c}ashi (cited in Al-Hamad 1986) points out that other sounds like /θ, f, ḍ/ can also be marked for [*mutafashshī*], but he claims that /ʃ/ is more dominant for the employment or manifestation of this feature. This is, of course, an impressionistic judgement and the adoption of this feature with sounds other than /ʃ/ is still controversial in the *tajwid* literature. One possible modern equivalent to [*mutafashshī*] is [distributed] (*SPE*). But the latter covers sounds that cannot be included under the traditional feature, such as /θ/ and /ð/.

(vi) [*mustaṭīl*]

The feature [*mustaṭīl*] 'stretched' refers to CA /ḍ/ rather than any other sounds because, as we have previously indicated, this sound has lateral characteristics and its description is problematic. This feature does not seem to have a suitable modern equivalent.

(**vii**) [*munḥarif*]

The feature [*munḥarif*] 'inclined/divergent' refers to the liquids /l/ and /r/. It is defined as the divergence of the sound from its original point of articulation towards the tip of the tongue for /l/ or the surface of the tongue for /r/ (ᶜUthmān 1981). This feature refers to the lateral characteristics of both sounds. When the airstream flows over the sides of the tongue after making the lingual contact it diverges over the sides of the tongue instead of being released from the place where the lingual contact is originally made. Makki (cited in Al-Hamad 1986) assumes that at the very initial phase for the production of a liquid (i.e. the alveolar contact) the articulators get prepared to produce a stop but such a target is not achieved and the airstream diverges to run out from a different point of articulation.

(**viii**) [*aghann*]

The feature [*aghann*] 'nasal' derives its significance from nasal assimilations and nasal articulation. Impressionistically, *ghunnah* 'nasality' refers to a sound that has resonance in the nasal cavity (Nasr 1992). The tongue plays no role in the production of this feature. That may be taken to imply that the early scholars could observe the role of velar lowering in the production of nasality.

2.3.2.3 Vowel features

An important aspect of the traditional feature system to consider is the treatment of vowel features. Three features are mentioned in the literature: *maḍmūm* 'rounded', *maftūḥ* 'open' and *maksūr* 'spread'. These features are articulatory because they denote lip positions. But it is worth noting that they cannot be assigned to vowels when they occur in isolation. That is, vowel features that refer to lip position are associated with the syllable as a separate articulatory unit and not with individual segments as such. The adoption of those features could imply that they are intended to account for an anticipatory assimilation processes where the consonant exhibits a feature from the following vowel such as labial rounding. It is also quite possible that the traditional scholars were unduly influenced by the Arabic writing system. It might be useful in future studies of the traditional feature system to see whether consonant assimilation to the vowel is a rule-governed behaviour or a mechanical process. One possible implication the findings could have for the phonological theory is that assimilation is not necessarily mechanical.

The three vowel features stated above are not included in the general *tajwid* theory of distinctive features. Tradition associates certain consonantal features with vowels such as the feature [*majhūr*] 'loud/voiced'. But it should be noted that this feature is redundant on the vowels because they are all voiced. Certain questions, however, will remain open to investigation. For example, why do the early scholars specify the vowels for [*mustafil*] 'low' rather than for [*mustaᶜlī*] 'levated/raised'? Does that have some articulatory basis or it merely implies that vowels are neutral segments as regards the tongue raising from its rest position? Is the current *tajwid* theory accurate for placing the vowels under the feature [*rikhw*] 'loose/fricative' whereas current theory places them under [approximant] which is equivalent to traditional [*bayna bayn*] 'in between'? Assuming that modern phonologists have been more accurate with their descriptions than the early *tajwid* scholars, then why do not the contemporary *tajwid* scholars extend the use of [*bayna bayn*] to cover the vowels instead of limiting its scope to consonantal segments only? Questions like these will remain open to critical evaluation of the traditional accounts.

2.3.2.4 Strong and weak features

Table (1) below indicates that the features that have been so far discussed fall into three categories: *qawiyyah* 'strong', *ḍaᶜīfah* 'weak', and *bayna bayn* 'in between'

The meaning of this classification is still unclear, at least from the modern phonetic point of view. *Tajwid* scholars (both old and modern) usually state briefly that a given feature is either strong or weak, but they hardly explain what they actually mean by that. Two interpretations are possible and they are both worthy of consideration. First, the strength or weakness of a feature could stand for its auditory characteristics, as is proposed by Al-Hamad (1986), and the effect the sound gives to the listener. Second, the two terms could refer to the amount of muscular activity which the speaker consumes in order to produce the sounds properly as reported by Abu-Shaᶜar (1996).

No	*Sifāt Qawiyyah* 'strong features'	No	*Sifāt Daᶜīfah* 'weak features'	No	*Byna Bayn* 'in between'
1	*majhūr* (loud/voiced)	1	*mahmūs* (whispered/ voiceless)	1	*muṣmat* (solid)
2	*shadīd* (stop)	2	*rikhw* (fricative)	2	*dhalaqiyy* (peripheral/ light)
3	*mustaᶜlī* (elevated/raised)	3	*mustafil* (low)	3	*bayn bayn* (approximant)
4	*muṭbaq* (lidded/velarized)	4	*munfatiḥ* (open/non-velarized)		
5	*ṣafīriyy* (sibilant)	5	*layyin* (soft)		
6	*munḥarif* (lateral)	6	*muqalqal* (agitated)		
7	*makarrar* (repeated/trill)				
8	*matfashshī* (spread)				
9	*mustaṭīl* (stretched)				
10	*aghann* (nasal)				

Table (1): Traditional classification of features according to strength and weakness

2.4.3 Assimilation (*idghām*)

2.4.3.1 Meaning and scope of assimilation in *tajwid* tradition

There seems to be no significant difference between the meaning of assimilation in *tajwid* and current phonetic and phonological literature. Both agree that assimilation is the change of one sound into another sound because of the influence of neighbouring sounds. There is a general tendency to assume that assimilation allows the speaker to achieve ease of articulation by putting less muscular effort on the articulators. But it should also be noted that a purely phonetic interpretation of assimilation would probably rule out the possibility that certain assimilations are part of the linguistic grammar. In other words, not all assimilations are mechanical and universal. The phonology will thus have the advantage of bringing to light the assumption that some assimilations are language-specific.

The major difference between traditional and current literature regarding the scope of assimilation is with the segments that can undergo this process. In *tajwid*, assimilation rules apply to two neighbouring consonants that are similar in some respects. The main condition for assimilation to be realized phonetically is that there must exist no intervening vowel between the consonants to obstruct it. There appear to be no restrictions on the direction of assimilation in this particular sense, i.e. as long as it is occurring between consonantal strings. So, CA uses both perseverative and anticipatory consonant-to-consonant assimilation. By contrast, assimilations that occur between consonants and vowels are not usually considered assimilations in the modern sense of the term. To be more accurate, they are presented and discussed separately, not along with the assimilation rules of *tajwid* and commonly under different headings. A good example is emphatic assimilation as it will be shown in the following chapters. But this study will demonstrate that it is more or less one pattern of assimilation.

2.4.3.2 Nasal assimilation

According to Nelson (1980), "one of the most obvious characteristics of Qur'anic recitation is the nasal quality (i.e. nasal assimilation). It is not to be attributed to custom, aesthetics or natural voice quality (although it may be intensified in a nasal voice), but to the rules of *tajwid.* These regulate what sort of phoneme and what sort of syllable is to be articulated through the nasal cavity" (p. 44).

Nasal assimilation falls into three categories; *idghām*, which literally means 'incorporation' and is translated by Arabists as 'assimilation', as stated above, *iqlāb* 'alteration' and *ikfā'* 'hiding'. The three patterns of assimilation apply to unvowelled nasals and nunation in a variety of contexts unless the sounds following the nasals are the six pharyngeals /ʔ, h, ʕ, ħ, ʁ, χ/. In that case the nasals will retain their articulatory correlates under a rule known as *idhār* 'manifestation' which prevents the occurrence of assimilation. It is worth observing that the six sounds above share the same place of articulation which is the pharynx in its broadest sense according to the traditional taxonomy of the places of articulation (see section 2.3.1 above). It is, therefore, plausible to treat these sounds as a natural class on the basis that they counteract nasal assimilation. The assumption that they are produced further back in the vocal tract than the remaining consonants is consistent with the assumption that similar sounds that share a particular feature or set of features tend to assimilate to each other. Thus, /n/ would tend to assimilate to a following labial stop because they both share the feature [labial]. But it does not assimilate to a following /ʕ/, for example, because they are hardly similar. We will discuss below the rules of nasal assimilation briefly.

(i) *Idghām* 'integration'

An utterance ending with unvowelled /n/ and followed by a word beginning with /j, r, m, l, w/ or /n/ the /n/ should undergo assimilation. This rule is only applicable across word-boundaries. Unless /n/ is followed by /l/ or /r/, the alveolar contact (for /n/) is not made. The tongue only assumes the configuration required for producing the following assimilating segment which turns into a geminate sound and the reciter is advised to substitute extended nasality (not to exceed the duration of six diacritics) for the alveolar contact of the assimilated /n/. On the other hand, if the assimilating sound is /l/ or /r/ the alveolar contact can be retained but there is no nasality. In other words, either the lingual contact or the extended nasality will occur depending on context. The only case where the labial nasal /m/ should be integrated is that if it is followed by another /m/ so as to produce a gemintate 'm'.

Examples:

(a) *faman yurid*

[fəmə̃j:jurid]

'for whom (He) wants'

(b) *kam min*

[kəm:min] 'how often'

(c) *min raḥmah*

[mirraħməh]

'of mercy'

(ii) *Iqlāb* 'alteration'

This rule only applies to the alveolar nasal /n/. Unlike (i) above, it only occurs in single words. It is basically a simple and straightforward rule that is usually applied intuitively whether in CA or in other styles. We assume that *iqlāb* 'alteration' is a good example of the speaker's intention to achieve ease of articulation and make the minimal articulatory effort possible. When /n/ is followed by /b/ the alveolar contact is not made, the nasality is extended to the duration of two diacritics, and the labial closure required for the production of /b/ is retained so as to produce [m] instead of /n/. That implies that there are some similarities between *iqlāb* and *idghām* such as the employment of extended nasality in both rules. It is sometimes recommended that the reciter would allow a little labial opening/gap (lowering) when articulating the /m/.

That could be a language-specific phonetic rule, probably one that is not realized in other styles.

Examples:

Within single words	Across word-boundaries
(a) *'anbatakum*	(b) *min ba^{c}d*
[ʔam̥:batakum]	[mim̥:baʕd]
'(He) grew you'	'until after'

(iii) *Ikhfā'* 'hiding'

If /n/ is followed by one the 15 sounds /s, ṣ, ð, ð̣, θ, ʃ, z, f, ṭ, t, d, ḍ, k, dʒ, q/ it is hidden (*tukhfā*). The question is what is the difference between *ikhfā'* and the other two rules described above? Perhaps the most significant difference between *ikhfā'* and *idgham* lies in the tongue configuration during the assimilation process. In *idghām* /n/ is completely assimilated to the following sound so that only the nasal airflow remains. In other words, the tongue tip does not make lingual contact with the alveolar ridge to produce the nasal consonant. In *ikhfā',* however, the alveolar contact is partly achieved which clearly affects the articulatory and auditory qualities of the resulting nasalized sound. For example, in *warizqun karīm* 'and glorious sustenance' the tongue assumes the shape required for the production of /n/ but the reciter allows a little space between the alveolar ridge and the tongue tip before making a complete velar closure for the following /k/. In the case of *iqlāb*, the /n/ is replaced by another sound which is [m].

The application of the three rules mostly requires the application of extended nasality and they all require some oral practice.

2.4.3.3 Assimilation in recitation: mechanical or grammatical?

We have discussed above three types of nasal assimilation and, impressionistically, some of these hardly exist in styles other than recitation. But it is important to note that nasal assimilation is not the only assimilation which is used in CA. *Tajwid* scholars use the following three covering terms to identify all the possible types of assimilation that may occur in recitation style including nasal assimilation:

(i) Assimilation of two identical sounds (gemination across word-boundaries).

(ii) Assimilation of two sounds that share voicing or manner feature(s).

(iii) Assimilation of sounds that have similar place or manner feature(s).

The first category refers to gemination between two adjacent (identical) sounds, each belonging to a separate word. Gemination, in this sense, occurs across word-boundaries. A similar notion applies to English utterances such as in *unnatural* and *unknown* where gemination between the [n] sounds in {un#}and {#na-} occurs across morpheme-boundaries. We tend to think that this process is mechanical and that many reciters would even apply it without having to learn it. Therefore, it might be pointless to claim that producing a doubled consonant is part of the linguistic grammar of Arabic. For instance, the two *l* sounds in *waqul lahumā* 'and say to them both' tend to become a geminate lateral which is made with one alveolar contact. The same assumption is true with strings like [m # m] in *kam min* 'how often' and the like. But in the latter utterance in CA the duration of the nasality is prolonged to the measurement of two diacritics which is uncommon in ordinary speech. In other words, extended nasality, not gemination, is language-specific and not universal.

Voicing or manner assimilation is applicable to a variety of sound strings such as alveolar /t/+/ṭ/ or /n/+/l/, interdental /θ/ + /ð/ or /ð/ + /ð̣/, and labial /b/ + /m/. Speakers probably carry out such assimilations automatically unless they want to articulate the segments very carefully. For example, /t/ is assimilated to the following /ṭ/ in *hammat ṭā'ifah* 'a party of them have plotted' and /n/ is assimilated to /r/ in *min raḥmah* 'of mercy'. In both utterances a single lingual contact is made and there exists no pause between the trigger and target segments. The tongue tip is pressed once against the alveolar ridge for the production of the assimilating sound.

Clear evidence for the existence of phonetic rules in CA comes from the third category of assimilation, where sounds assimilate to each other because they share similar place or manner phonetic properties. This can be observed in some of the nasal assimilations discussed in the previous section. The following are additional examples and some comments.

Examples:

(a): /n/+ /j/: *faman yurid* [famaj̃:jurid] 'for whom (He) wants'.

(b): /n/ +/ṭ/: *inṭaliqū* [ʔiṇ:ṭaliqu:] 'depart ye'.

(c): /n/ + /s/: *'insān* [ʔinsæn] 'human being'.

(e): /n/ + /ʃ/: *'inshā'llāh* [ʔiṇ:ʃa:ʔalla:h] 'if God willing'.

(f): /n/ + /q/: *min qawlin* [miṇ:qawlin] 'of saying (something)'.

In ordinary speech speakers do not tend to assimilate certain nasals to the following sounds. It is also uncommon (and may even sound odd) that someone could produce extended nasality of any duration when reading out an ordinary text. In other words, some kinds of nasal assimilations cannot be regarded as a low-level articulatory phenomenon which is necessary to save the speaker's effort and economize the activities of his vocal tract. Some nasal assimilations cannot be attributed to bio-mechanical factors which the speaker is not necessarily aware of. The phonetics alone cannot provide a satisfactory explanation for why /n/ should be assimilated to a uvular /q/ as in (f) above but not to a uvular /ʁ/ or /χ/. Indeed, we can see no clear reason why that should be the case. In other words, it is quite possible to assimilate /n/ to /ʁ/ or /χ/ exactly as it is assimilated to /q/. Consider the examples below.

Examples:

(a): /n/ + /q/: *min qawlin* [mi̥ŋ:qawlin] 'of saying (something)'.

(b): /n/ +/ʁ/: *min ghayr* *[mi̥ŋ:ʁayr] 'of else'.

(c): /n/ + /χ/: *min khawf* *[mi̥ŋ:χawf] 'against/from fear'.

The fact that (b) and (c) are not used in *tajwid*, even though it is possible for many speakers to articulate them, clearly supports the claim that assimilation occurs in (a) for language-specific and not mechanical reasons. To the best of my information, it is not always easy to produce nasal assimilations properly in recitation, and some beginners may consider them a challenge. The configuration of the tongue during the production of the nasal airflow, the duration of nasality, the amount or amplitude of the airflow escaping from the nasal (and sometimes the oral cavity) and more significantly, the sounds that undergo the assimilation process and the sounds that do not appear to be all language-specific. The observations mentioned so far shed some light on Nelson's (1980) comment that it is more appropriate to attribute nasal assimilation in CA to the rules of *tajwid* and not to something else (see section 2.4.3.2 above). Our observations are also relevant to Pierrehumbert and Beckman's (1988) criticism of *SPE* for its complete separation between the phonetics and phonology and, consequently, the ruling out of the significance of some phonetic phenomena that appear to be part of the linguistic grammar.

2.5 Other rules of *tajwid*

Before we conclude this chapter it might be useful to shed some light on three additional rules: vowel prolongation, pause and beginning, and recitation mode (speech rate). The study of these rules may appeal to phonologists and phoneticians, though it could also be argued that they involve timbre, melody and chanting and, therefore, they are of a non-linguistic nature. It might be possible to find a correlation between some of these rules, such rules of pause, and the semantic value of utterances in the *Qur'an*. Also, in certain cases it might be interesting to study unexplored phenomena in CA such as intonation or stress patterns and relate them to problems of speech rate which is important in *tajwid*. Whatever the possibilities and options available to the linguist are these rules are still part of the theory of *tajwid*. Therefore, we prefer to describe them briefly.

(i) Vowel prolongation

Vowel prolongation is dependent on phonetic context. The long vowels /i:, a:, u:/ are extended in some positions up to the duration of six diacritics. This rule covers all the possibilities where these vowels can be prolonged either optionally or obligatorily in recitation. For example, if the vowel is followed by a glottal stop in the same word the long vowel should be prolonged to the duration of 4-6 diacritics such as in *'ula'ika* 'those' and *sī'āt* 'grieved'. The application of this rule is common before pauses as in *al-ḍāllīn* 'those who go astray' (*al-ḍāllīna* if there is no pause). Prolongation is further applicable to utterances containing geminate consonants after the long vowels as in *al-hāqqah* 'The Sure Reality'.

Why are vowels prolonged in certain contexts and not in some others? First, that could be related to timbre, tune and chanting so as to improve the reciter's oral performance. Second, it could have a phonological/phonetic basis as suggested by Al-Hamad (1986). If the vowel is not prolonged the following sound (a glottal stop, a geminate consonant, etc.) may not be pronounced properly because of the mutual articulatory effects between the vowel, on the one hand, and the following sound, on the other. In other words, it is expected that by prolonging the vowel duration the reciter will avoid hidden (phonetic) mistakes.

(ii) Pause and beginning

The rules of pause and beginning regulate the cases where the reciter is motivated to continue recitation or stop it. They were originally adopted to help reciters take care of the content of the utterances (i.e. their meaning). This implies that the early scholars did not only focus on describing articulation of sounds and the formulation of formal rules such as those discussed above. The meaning of utterances was also taken into consideration and, as with other languages, meaning is essential to speech. Scholars added some punctuation marks and special symbols to Qur'anic texts to clarify pause and beginning positions.

(iii) Speech rate

Speech rate of recitation may help the reciter achieve his ideal phonetic targets successfully with the condition that he knows *tajwid*. *Taḥqīq* (very slow), *tartīl* (slow), *tadwīr* (medium) and *ḥadr* (fast) are different speech rates mentioned in the literature. With the exception of *taḥqīq* which is reserved for pedagogical purposes (Denny 1989), the other three modes are available to all reciters. There seems to be no objective criterion according to which a particular speech rate can be judged for being right or wrong. It is generally a question of personal choice and preference. It is the reciter who normally selects the mode that suits him most for a number of psychological and social factors which he thinks are important.

2.6 Summary

In this chapter we introduced three major aspects of the *tajwid* theory and discussed them from a modern phonetic and phonological perspective: places of articulation, manners of articulation and assimilation. The traditional descriptions of the places of articulation of CA segment are primarily impressionistic because the early scholars had no physiological equipment to investigate speech production experimentally. Nevertheless, those descriptions, though sometimes difficult to follow, do not apparently contradict the main findings of modern phoneticians. Both schools of phonetics, that of *tajwid* and that of experimental phonetics, agree on many aspects of how speech sounds are produced. Differences between the two schools are likely to be with the amount and clarity of physiological detail each provides. Thus, while *tajwid* merely relies on individual observation and impressionistic judgement in approaching the point of articulation of each single consonant, modern phonetics relies heavily on experimentation. Both schools have no clear explanation for how vowels are produced, and it appears that this problem is tackled differently by each. Modern phoneticians are also engaged in a number of problems regarding the organs involved in the articulation of pharyngeals.

There seems to be no intrinsic difference between tradition and current phonological theories regarding the adoption of a limited number of binary and unary features. That clearly shows that there exist general areas of interest which are shared by both *tajwid* scholars and contemporary phonologists. In fact, theories of distinctive features are probably as ancient as linguistic thought itself. It would be misleading to claim that the featural approach was first initiated by the ancient Arabs. For example, Ghali (1976) states that the ancient Indian grammarian Panini identified a set of distinctive features in the phonology of Sanskrit. But it is absolutely correct that the *tajwid* scholars were among the early scholars who appreciated the significance of distinctive features for the phonological analysis of language. Features in *tajwid* are primarily consonantal and some of them can be associated with vowels. There are also features that could be morphological. Thus, the feature system of *tajwid* still requires further investigation in order to assess its validity and phonetic accuracy in the light of our modern understanding of the phonology and phonetics. Particularly with the phonetics, some traditional claims that sibilants, for example, tend to vary from one another regarding the degree or amount of sibilance are worth testing experimentally.

We further discussed assimilation, particularly that of nasals. It was argued that the scope of assimilation as a formal rule in *tajwid* is not the same as in current theory. *Tajwid* limits assimilation rules to consonantal strings while the vowels are completely eliminated. Assimilation of vowels is treated under different headings and treated within a different theoretical framework. A good example of the traditional separation between what may be called assimilation and what may not is the treatment of emphatic spread, as shown in the coming chapter.

Finally, we discussed briefly the issue of the phonology-phonetics interface in an attempt to find out whether there exists some correlation between language-specific phonetic rules and nasal assimilation in CA. It was argued that the existence of these rules could be demonstrated and, therefore, the sharp *SPE* division between the phonology and phonetics is not accurate. Some nasal assimilations, and not necessarily all, are language-specific and they do not even exist in other styles of Arabic. The main point is that assimilations may not be always explained in terms of the bio-mechanical requirements of speech production.

The following chapter will deal with emphasis, including the traditional conception of emphatic assimilation. We will also discuss modern experimental findings about emphatic articulation and other topics related to emphasis, some of which are still controversial. Emphatic assimilation is a significant phenomenon to study both for its phonetic complexity and for the ways it has been analyzed in both traditional and modern phonologies. It is a topic which will hopefully provide us with important clues to the issue of the phonology-phonetics interface within the general theory of generative phonology.

CHAPTER THREE
LITERATURE REVIEW ON EMPHASIS IN ARABIC

3.1 Introduction

The study of emphasis in Arabic, whatever the style investigated might be, is a significant area of scientific research and debate which is of potential interest to both phoneticians and phonologists. The term 'emphasis', which is used by Arabists as equivalent to Arabic *tafkhīm* 'grandeur/dignity', is the conventional phonological covering term referring to a group of coronal and guttural consonants whose articulation is characterized by raising the back of the tongue. There are two categories of emphatics, one involving a complete lingual contact with the uvula/velum as a primary articulation, and the other involving a partial raising of the tongue back toward the velum as a secondary articulation. In the latter, the primary articulation is achieved in the anterior part of the oral cavity. The first category of sounds comprises /χ, q/ and /ʁ/ (uvulars) and the second category comprises /ṭ, ṣ, ḍ/ and /ð̣/ in addition to alveolar /r/ and /l/ in certain environments.[15] This is basically the traditional description, which classifies sounds into emphatic and non-emphatics by mainly considering the tongue back raising which, in effect, characterizes the articulatory and auditory qualities of the sounds involved. According to this approach emphatics

[15] Note that the symbols /χ/ and /ʁ/ stand for a uvular point of articulation according to the IPA chart and that the sounds represented by these symbols could be velar depending on the style spoken so that the appropriate symbols would be /x/ and /ɣ/ instead. We prefer to call CA /ḍ/ alveolar in accord with modern studies of Arabic dialects because we are not quite sure how the classic sound can be produced (see Chapter Two for details).

may be phonetically described as velarized, which is a possible equivalent translation of Arabic *muṭbaq* (literally 'lidded').

As a result of some recent developments in experimental phonetics and the evolving interest in the objective observation of speech production and the complex nature of the vocal organs' activity (particularly in the pharynx), a number of studies have been performed to explore the articulatory mechanism that underlines emphasis. Many of these studies have rejected the traditional impressionistic assumption that emphatics are velarized and adopted the view that they are actually pharyngealized. This view has become, indeed, dominant in modern phonetic literature, but not everyone agrees. In short, emphatic articulation is a problematic and controversial issue in modern experimental phonetics, and it is not yet clear how emphatics are articulated.

The literature review will first deal with emphasis in phonetics. Unlike in *tajwid* tradition, the number of emphatics in current studies is controversial not only because of variation between dialects but also because the source of emphasis in an utterance is problematic as the discussion about the phonology of emphasis will show later. Emphatic articulation will be discussed next. It will be demonstrated, by the presentation and criticism of different views, that it is not yet clear how emphatics are produced. The problem of emphatic assimilation as a phonetic process will also be considered. That will lead to the discussion of the acoustic correlates of the vowels when their articulation is affected or modified under the influence of neighbouring emphatics. The importance of the previous acoustic studies of emphasis lies in our attempt to select an appropriate acoustic parameter to measure in the experiment so as to explore some implications emphasis could have for current theory and to shed some light on the phonology-phonetics interface in CA.

The literature review will further raise a number of phonological and phonetic questions about emphasis such as: (i) How far can emphasis extend or spread to adjacent segments regardless of the features assigned to it whether in *tajwid* or current phonological theories? (ii) If an utterance is completely or partially emphasized where does emphasis start from? (iii) Is emphasis a consonantal feature, a vowel feature, a prosodic feature, or something else? (iv) How can we best account for emphatic spread in Arabic? Will it be in purely phonetic terms of emphatic coarticulation, in formal phonological terms of spreading rules that affect segments in a categorical way, or in both?

The study of emphasis in Arabic in a number of traditional and modern works shows that emphasis is not restricted to one specific segment but it rather spreads over a group of neighbouring segments regardless of their position and their phonetic characteristics. Although it is found in all spoken dialects/styles of Arabic, there are strong reasons to assume that emphatic spread is variable from one Arabic style to another. Various phoneticians and phonologists have attempted to describe this phenomenon in terms offered by their theories whether as a phonetic problem of coarticulation or as a phonological rule which treats emphasis as a linguistic or grammatical feature that has a domain and can either be spread or blocked depending on factors such as syllable structure and vowel quality. Those studies were usually devoted to Arabic colloquials and in some cases it was reported that dialects exhibit variable and unpredictable patterns of emphatic spreading even in the closely related dialects (Hoberman 1989). Although no adequate autosegmental representation has yet been developed to account for emphatic spreading in CA and MSA, which is a major drawback in current theory, those studies could provide useful insights into the problem of emphatic spread in Arabic. It is, therefore, our role in this study to derive empirical and theoretical conclusions about the way emphasis is spread and blocked in both styles. Differences between CA and MSA may be easier to handle than between either style and the colloquials because the two standard styles are considerably similar. That will hopefully make the comparison more fruitful and the results more promising in the coming chapters. Treating emphatic spread as a completely phonetic phenomenon may not be appropriate although there may exist evidence that emphatic assimilation could be influenced by the bio-mechanic requirements of the vocal tract activity. In general, however, this point may remain controversial. But our main objective in the following chapters will be to investigate emphasis in CA/MSA within the framework of the phonology-phonetics interface. The information given in this chapter will hopefully highlight our discussion later on.

3.2 Emphasis in classical phonetics (*tajwid*)

3.2.1 Number of emphatics

Traditionally, Arabic *mufakhkhamah* 'grand' (emphatic), which is opposed to *muraqqaqah* 'delicate' (plain), is a covering term for four categories of sounds:

(i) Sounds which are emphatic in all contexts and these are the velarized consonants /ṭ, ṣ, ḍ, ð̣/ and the uvulars /q, χ, ʁ/.

(**ii**) Sounds which are frequently plain (*muraqqaqah)* but they occasionally become emphatic. This category only includes lateral / l/ when it comes immediately after /a/ in *Allah* [ʔalla:h] 'God'.[16]

(**iii**) Sounds which are frequently emphatic but they occasionally become plain in some environments. This category only includes trilled /r/ which is usually emphatic in a number of contexts but it becomes plain when it is, for example, preceded by /i/ as in *firqah* 'group'.

(**iv**) Sounds which are neither plain nor emphatic but they follow the emphasis or plainness of the sounds that immediately precede them. This category only includes /a:/ (*al-'alif al-mufakhkhamah*) and consequently its short counterpart (*al-fathah*) depending on whether it is preceded by an emphatic consonant such as in *ṣāra* 'became' or a plain consonant such as in *sāra* '(he) walked'.

The term 'emphatics' generally refers to the seven consonants indicated in (i) above on the basis that they are constantly emphatic in all sound environments. In other words, they are inherently or categorically identified as emphatic segments unlike /l/, /r/, and /a(:)/. The majority of *tajwid* scholars treat the uvulars as emphatic consonants and do not differentiate them from the velarized consonants in this particular sense. But they occasionally claim that the latter category of sounds involve a stronger degree of emphasis than the other category. However, the scope of *tafkhīm* 'emphasis' and its precise articulatory correlates in tradition is a bit problematic as it will be indicated soon.

[16] The status of /l/ is interesting because the occurrence of its emphatic allophone is not exactly dependent on context. See section 3.2.2.1 below for further discussion.

3.2.2 Scope of emphatic articulation in *tajwid*

Makki (d. 1017) and Al-Murādi (d. 1329) raise a problem which is not tackled seriously especially in current *tajwid* literature. They simply suggest that the uvulars should be totally eliminated from the class of emphatics and restrict the use of the term to the velarized coronal consonants. Abu-Sha^c ar (1996) states that Makki thinks that the uvulars should not be counted emphatic but they rather exhibit emphasis in certain contexts such as when /ʁ/ is followed by /a/. In other words, what he suggests is that the uvulars behave like /l/, /r/ and /a(:)/ since the occurrence of their emphatic and plain allophones is conditioned by context. Al-Muradi similarly limits the number of emphatics to the velarized consonants and /l/, /r/ and /a(:)/ in certain contexts and does not include the uvulars. Having in mind that both scholars adopt the view that producing the uvulars involve the raising of the tongue back toward the uvula, their conception of emphasis differs considerably from that of the majority of scholars who assume that the sounds that share the raising of the back of the tongue are all emphatic. In short, it might be possible that Makki and Al-Murādi are not equating emphasis with the tongue back raising and that the articulatory and/or auditory correlates of velarization is somewhat irrelevant to the question of what emphasis could actually imply. Their approach could mean one of the following possibilities:

(i) Emphasis is basically an auditory correlate that merely characterizes velarized consonants, but not the uvulars.

(ii) Emphasis is an articulatory correlate. It merely refers to the secondary articulation which characterizes the production of the velarized consonants by the raising of the tongue back toward the soft palate.

(iii) Emphasis is an articulatory correlate but it does not refer to the raising of the back of the tongue towards the soft palate but to another articulatory activity. That is why the uvulars cannot be regarded as emphatic.

The suggestion in (i) that emphasis is merely an auditory correlate (or feature) is supported by Ibn Al-Jazari's definition of emphasis and plainness (cited in Abu-Sha^{c}ar (1996: 271). Ibn Al-Jazari (d. 1429) states that emphasis is "thickness that enters into the body of the consonant so that the mouth fills with its echo" and plainness (which is the opposite of emphatic) is "thinness that enters into the body of the consonant so that the mouth does not fill with its echo". Since 'echo' is basically a sound which hits a surface and comes back to be heard a second time it is possible to assume that Ibn Al-Jazari is more or less referring to an auditory feature. Accordingly, Makki and Murādi may be referring to the same feature which they could have thought that the uvulars do not have.

As for (ii), the restriction of emphasis to the secondary articulation, we have found no explanation of why Makki and Al-Muradi do not consider the uvulars emphatic consonants. They exclude the uvulars from the class of emphatics and at the same time they assign them the feature [*musta^{c}lī*] which denotes the tongue back raising. We are inclined to think that emphasis must involve multiple/double articulation in the vocal tract. The main problem that can be seen with Makki's argument is that the uvulars get emphasis from an adjacent segment such as /a/. It is not quite clear why /ṭ/, for example, can be the source of emphasis in a given utterance, but /q/ cannot. Also, as will be seen below, the treatment of the vowel as an independent emphatic segment that colours the uvular consonant with emphasis needs to be justified.

The third argument could have implications for modern physiological studies of emphasis. Recall Ibn Al-Jazari's definition of emphasis which he describes as thickness that is added to the body of the consonant. That could simply imply that he is referring to the tongue back raising which is crucial to the phonemic distinction between the emphatic coronals and their plain counterparts (which are /t, s, ð, d/). But it could also be argued that Ibn Al-Jazari is not referring to the tongue back raising but rather to a different mechanism which he calls 'thickness' but he gives no further explanation of the term. In that case, his description could imply that the reciter can employ an extra articulatory activity whose absence does not necessarily affect the meaning of the utterance. For example, emphatic allophones of /χ/ can be produced as in *khālidan* '(he is) immortal', where the uvular consonant could be more emphatic than in *ikhwatu* 'brothers'.

If the problems raised above could be brought into light in future studies it might be possible to see closely why the traditionalists say that the velarized consonants are more emphatic than the uvular consonants. Naṣr (1992), for example, states that emphasis is stronger with the velarized consonants and that the strongest and most emphatic consonant is /ṭ/ while /χ/ is the weakest and least emphatic. He further conceives emphasis as a continuum (following the early scholars) so that /ṭ/ is placed at the top, /χ/ at the bottom and /ḍ, ṣ, ð̣, q, ʁ/ in between, in that order. Accordingly, there is a smaller difference between /ṣ/ and /ð̣/, for example, than between either of them and /χ/ on the basis that they exhibit more emphasis. At the same time, there is also a small difference in degree of emphasis between /ṣ/ and /ð̣/.

However, unless we see the scope of emphatic articulation in CA more closely we cannot demonstrate that emphasis involves articulatory processes other than the ones which are explicitly indicated in the literature. Therefore, will continue to assume that the *tajwid* scholars are not referring to an articulatory activity other than the tongue back raising when they come to describe emphatic articulation.

3.2.3 Emphatic assimilation as discussed in *tajwid*

3.2.3.1 Scope of emphatic assimilation

Two classical approaches to emphasis need to be distinguished. The first of these treats emphatic assimilation as a phonological rule that merely applies to CV segments. This rule is not usually included under the heading of assimilation because assimilation in tradition is limited to consonantal strings. The second approach is primarily phonetic. It is concerned with the way emphatics may affect adjacent segments, both consonants and vowels. This approach will be explained briefly below.

3.2.3.2 Emphatic assimilation between consonantal segments

In most Arabic colloquials emphasis spreads over a number of segments. This has been discussed by a number of phonologists such as Card (1983), Davis (1989) and Younes (1993). In classical recitation style it is only supposed to spread to the following vowel. In other words, it is not supposed to affect other consonants. This causes a problem for the reciter. We will now discuss briefly some of points which have been said in the *tajwid* literature about this problem from the reciter's point of view.

It is quite possible that the intrinsic nature of the emphatic gesture is such that it tends to affect most of the consonants that occur in its vicinity. However, from the point of view of *tajwid*, unless the effect is dictated by a language-specific rule, plain consonants are required to remain plain on the phonetic output. In other words, an ideal reciter should not allow emphasis to have low-level effects on nearby plain consonants. It is, therefore, expected that reciters would have to adjust their daily speech habits, which apparently show a lot of those effects, so as to meet the traditional standards of good recitation. Thus, in *barq* [bərqə] 'lighting', for example, the emphatic gesture in [ṛ] and [q] should not anticipate to the initial [b] even though the speech mechanism may dictate that. Similarly, in *bāṭil* [bæṭil] 'false/sin' neither the initial stop nor the final lateral should turn into emphatic. Controlling the domain of the emphatic gesture requires some oral practice. This could be true especially with utterances that contain consecutive antagonistic emphatic-plain-emphatic or plain-emphatic-plain sequences as in *dhahara* [ðahəra] 'it appeared' and *wa-nakhlā* [wənəχlæ] 'and palm trees'. Also, an emphatic consonant which is contiguous to a plain consonant as in *ḥaraṣtum* [ħəraṣtum] 'you have been careful' and *basṭah* [bəsṭah] 'spreading' is not supposed to affect it. Therefore, the strings [-ṣt-] and [-sṭ-] in both words are not supposed to be pronounced in the same way.

According to Al-Hamad (1986), when a plain consonant is followed by an emphatic one, it is quite common that the former assimilates to the latter. He states that the early scholars observed that the tongue tends to assume the configuration required for the production of the emphatic consonant early enough before it is actually produced. So, while producing *basṭah* (above) the reciter has to constrain the tongue back raising until he actually comes to articulate the emphatic consonant. Speakers with little knowledge of *tajwid* may tend to produce the word as [baṣṭah] instead of [bəsṭah]. One of the factors that probably lead to this phenomenon, which might not be realized in a more careful speech, is the existence of a phonemic emphatic /s/ in many Arabic dialects. Therefore, poor reciters would automatically substitute [ṣ] for /s/. Consequently, the transition between segments in the string [-sṭ-] would be smoothed out and the speakers would consume less articulatory effort than if they want to articulate the two segments as recommended.

It is possible to assume that emphatic assimilation between consonantal segments is primarily a phonetic problem that can be solved with oral practice, reading instruction manuals and getting experts' advice. It is usually recommended that the reciter should control the emphatic gesture in various contexts and avoid dialectal interference with CA.

3.2.3.3 Emphatic assimilation and vowels

All the six CA vowels fall under the influence of neighbouring emphatics in CV strings. According to Abu-Sha^{c}ar (1996), however, the early scholars point out that the effect of emphatics on vowels is not consistent. *Tajwid* scholars adopt the notion of *marātib al-tafkhīm* 'degrees of emphasis', meaning that certain vowels exhibit more emphasis than others. Therefore, it is quite possible, particularly with a relatively small set of vowels as in CA, to divide their emphatic allophones into degrees that range from the most emphatic to the least emphatic allophone. Two opinions are attested in *tajwid* tradition regarding degrees of emphasis. The first of these is attributed to Ibn Ṭaḥḥān (an early scholar) who states that /a(:)/ is the most emphatic, then /u(:)/ and finally /i(:)/. The second opinion is adopted by Ibn Al-Jazari (d. 1429) who states that /a:/ comes first, then /a/, /u(:)/ and finally /i(:)/ (Abu Sha^{c}ar 1996). These opinions will remain open to experimental investigation.

3.2.4 Summary of *tajwid* literature on emphasis

In short, the traditional treatment of emphasis in the *tajwid* phonetics covers three topics: the number of emphatics, their articulatory properties, and their effects on neighbouring segments. It is possible to divide CA segments, whether consonants or vowels, into three categories. The first category comprises segments which are always emphatic and these are /ṭ, ṣ, ḍ, ð̣, χ, q/ and /ʁ/. The second category includes /l, r/ and /a(:)/ which may be emphatic or plain depending on phonetic context. The third category covers all the remaining plain segments.

The early descriptions (which are still adopted in modern *tajwid* literature) indicate that emphatics are produced with a tongue back which is raised towards the soft palate (velarization). However, the exclusion of the uvulars from the class of emphatics by some scholars could imply that emphatic articulation involves unexplored vocal activities other than the tongue back raising. This is a point that is left unresolved in our presentation.

Emphatic consonants tend to influence and modify the articulatory properties of neighbouring consonants and vowels. The effect on consonants is not recommended in tradition unless it is dictated by a specific rule of assimilation. Emphatic assimilation between consonantal segments is regarded as a problem whose solution lies in learning and oral practice. On the other hand, the effect of emphatics on the immediately following vowels is traditionally conceived as a continuum that ranges from the most emphatic to the least emphatic vowel.

3.3 Emphasis in modern phonetics

3.3.1 Number of emphatics

As discussed above, *tajwid* scholars regard as emphatics the velarized consonants /ṭ, ṣ, ḍ, ð̣/ and the uvulars /q, χ, ʁ/ in addition to /l/ and /r/ in certain contexts. They do not specify vowels for either emphasis or plainness, on the assumption that vowels acquire either feature from the preceding consonant. Two approaches to the identification of emphatics are adopted in tradition. The first approach is primarily articulatory or phonetic because it focuses on the question of how the sounds classified as emphatic are produced. It makes an explicit mention of the tongue back raising in the production of the velarized and uvular consonants.

The identification of emphatics and their number in Arabic is not straightforward. The principal problem is the inconsistency among Arabic dialects as regards the number of emphatics they have, the way these emphatics are articulated, and the extent to which they affect adjacent segments and modify their articulation. Another factor is the existence of certain phonological approaches to the identification of emphatics and the way they determine the source of emphasis in utterances.

The number of emphatics in modern dialects of Arabic is not consistent. This problem is reported by Davis (1993) who states that dialects vary as to which emphatics they actually manifest and no dialect has all of the sounds: [ṭ, ṣ, ḍ, ẓ, ð̣, ṛ]. The exclusion of the uvulars by Davis implies that he does not consider them emphatic unlike, for example, Bakalla (1982), Jarrah (1993) and Card (1983). Other sounds are also mentioned in the literature such as [ḅ, ḳ, ṃ] (Ali and Daniloff 1972 and 1974 and Harrell 1957), [ḷ] (Laradi 1983) and [g̣, ʃ̣, x̣, ɣ̣, ḥ, ṇ, ẉ, ỵ, ʔ̣] (Harrell 1957). They occur in Baghdad Arabic (Iraq), Tripoli Arabic (Libya) and Cairene Arabic, respectively.

Moreover, not all of the emphatics are articulated the same way in all dialects. For example, /ð̣/ in CA in pronounced /ẓ/ in Cairene and Hejazi Arabic, /ḍ/ in CA is pronounced /ð̣/ in Najdi and other dialects, and /ʁ/ in Kuwaiti Arabic is more emphatic than its equivalent in other dialects. In fact, plain pharyngeals /ħ/ and /ʕ/ can be heard as emphatic in some dialects spoken in the Gulf countries. In short, emphasis in dialects covers a wider range than emphasis in CA and in some cases any plain sound could be realized as emphatic.

Furthermore, variation between dialects in the number of emphatics and the extent to which these sounds can affect adjacent segments also gives rise to studies of emphatic coarticulation. Phoneticians started to observe that some emphatics are not true emphatics because their coarticulatory effect is so limited that it hardly exceeds the preceding and/or following vowel, unlike the velarized consonants, which can affect several syllables in an utterance and the effect may even extend across word-boundaries. That is why Laradi (1983) regards some emphatics as secondary.

Among the first people who appreciated the need for a phonological approach to the identification of emphatics are Ferguson (1956), Harrell (1957) and Obrecht (1968), whose writings have probably influenced some recent autosegmental studies of emphasis. Ferguson (1956) states that emphatic /l/ in Arabic is an independent phoneme and that [ḷ] and [l] should no longer be treated as allophones of the same segment. He argues that since the occurrence of emphatic /l/ whether in the word for God in CA or in some other utterances in colloquials is unpredictable and is not bound to context as with the allophones of other segments then it should be treated as a separate phoneme. Ferguson also thinks that the uvulars are semi-emphatics because of their limited effects on neighbouring vowels. Harrell (1957) divides emphatics into the categories primary, secondary and marginal depending on their distribution and occurrence in minimal pairs. Thus, the velarized coronal obstruents are primary emphatics, [ṛ, ḷ, ḳ, ḅ, ṃ] are secondary emphatics and the uvulars are marginal emphatics. The division of emphatics into primary and secondary was later adopted by some phoneticians such as Ghazeli (1977), Card (1983) and Laradi (1983). Obrecht (1968: 41) recommends that the non-velarized consonants should be thoroughly studied. He states that "if these sounds are to be considered as members of some single class, then they must possess at least one common feature, or combination of features. One would expect to find some overriding similarity which crosses all the phonetic classes in which they are customarily said to occur".

Unfortunately, the recommendation made by Obrecht may encounter a number of challenges the most difficult of which is the disagreement among modern phoneticians about the essence of emphatic articulation. In other words, we are still unable to come across an integrated and solid conclusion about the physiological details of emphatic articulation so as to shed more light on Obrecht's assumptions. *Tajwid* probably has no solution for this problem not only because it is not an experimental field of study or because it is merely devoted to CA but also because emphasis is a variable phenomenon that is difficult to describe in a general way. Modern phoneticians, in spite of the availability of advanced tools for the study of speech production, are still uncertain about the question of how the vocal organs operate together to produce emphatics. It will be indicated below that emphatic articulation is a controversial topic. So, it would also be expected that they cannot come up with a final decision about the number of emphatics in Arabic. The two problems complement each other .

3.3.2 Scope of emphatic articulation in modern studies

3.3.2.1 Emphasis as velarization

The assumption that emphasis is velarization is very conventional especially in classical phonetics in Western Schools of linguistics. Velarization as a secondary articulation which characterizes the production of some sounds is equivalent to *iṭbāq* 'lidding' in the *tajwid* phonetics. A number of linguists, including Gairdner (1925), Ferguson (1956), Obrecht (1968), Ladefoged (1982 and 1997) and Kenstowicz (1994), make explicit mention of velarization whether in Arabic or in some other languages such as English, which allophonically distinguishes velarized or dark [ḷ] from non-velarized or plain [l] by raising the back of the tongue towards the velum as a secondary articulation. Treating emphasis as velarization has the drawback of eliminating the uvulars from the class of emphatics since the tongue back raising is primary for their production. As Laufer and Baer (1988) comment in their discussion of the uvular consonant /q/, it is not clear how a uvular consonant can have a primary and secondary articulation in the same area at the same time. One possible solution they propose is to classify emphatics physiologically into (i) anterior sounds associated with velarization as a secondary articulation, and (ii) sounds distinguished by identifying their primary place of articulation. In the second category the contrast is made between velars and uvulars such as /k/ vs. /q/.

Some phoneticians, such as Obrecht (1968), do not seem quite sure whether emphasis is realized as velarization or as pharyngealization and that is probably why he uses the two articulatory correlates interchangeably. He is criticized by Laufer and Baer (1988) who say that he uses phonetic terms loosely. Actually, Obrecht's study is primarily acoustic and it addresses a number of issues related to emphasis such as the number of emphatics, their status as a natural class and the domain of emphatic spread. He does not discuss the detail of emphatic articulation apparently because his study is not articulatory.

Jakobson (1962: 511-3) indicates that emphasis involves velarization or pharyngealization. According to him, "the characteristic articulatory feature of all the emphatic phonemes is the constriction of the upper pharynx". He further reports that "usually the production of pharyngealized buccal phonemes is accompanied by a velarization". It is not quite clear from his statements whether the relationship between velarization and pharyngealization is so intrinsic that when either of them occurs the other must occur or that one of them must always occur while the other (probably velarization as the discussion implies) is optional and conditioned by a number of factors. But Jakobson continues to employ the notion of secondary or multiple articulation which was originally velarization with all the traditional emphatics whether they are anterior (he calls them pharyngealized dentals) or posterior (pharyngealized velars/uvulars). But it is not clear whether his solution fits with articulatory facts about emphatic articulation especially when we come to consider emphasis in different Arabic varieties. In any case, the claim that emphasis is velarization encounters a number of empirical challenges in conventional phonetic literature.

3.3.2.2 Emphasis as uvularization

Descriptions of emphasis as uvularization can be found in a few works such as Lehn (1963), Kahn (1975) and McCarthy (1994) where this articulatory correlate is generally ill-defined. Lehn's work is primarily phonological. He follows the traditional linear approach to the analysis of emphasis and addresses the problem of identifying the source of emphasis in an utterance. But he does not go beyond mentioning uvularization, along with other terms that have been coined in an attempt to define emphatic articulation properly. His descriptions, though not quite clear, show that he does not adopt the view that emphasis is uvularization. He says that one of the articulatory correlates of emphasis is the raising of the back of the tongue which is more or less similar to velarization. But he also thinks that the claim that emphasis is velarization alone fails to capture the phonetic complexity of emphatic articulation. Kahn (1975) also makes mention of uvularization among some other terms, and cites

Lehn but with no further comment. Her study is primarily acoustic and devoted to the sociolinguistic aspect of emphasis and the way emphasis can be used to distinguish between speakers from the two sexes. Therefore, neither Lehn nor Kahn is interested in the detail of emphatic articulation.

The claim that emphasis is uvularization is also made by McCarthy (1994), who says that "the so-called pharyngealized consonants of Arabic should really be called uvularized" (p. 218). It is quite possible that McCarthy bases his argument on an interpretation of the early Arab grammarian Sibawayh (d. 809), who defines emphasis in terms of the tongue back raising. But neither Sibawayh nor his followers made explicit reference to the uvula. According to them, the back of the tongue is the crucial articulator and they do not distinguish between the uvula and velum (soft palate) in their descriptions of emphasis. Moreover, McCarthy's argument is a bit confusing. He recommends that emphatic coronals are to be called uvularized, yet he also states that "the uvular gutturals share with *q* and the coronal emphatics a constriction in the oropharynx produced by raising and retracting the tongue body" (p. 219). So, it is not quite clear whether he thinks that emphasis involves only uvularization or is also accompanied by pharyngealization. However, it should be noted that McCarthy's interest is mainly phonological and provides no new empirical physiological evidence to support his claims. That makes his comments very much similar to those of Lehn (1963) and Kahn (1994) above.

3.3.2.3 Emphasis as pharyngealization

The claim that emphasis is realized as pharyngealization is dominant in current literature (especially the experimental literature). It has the advantage of treating emphatic coronals and uvulars as one natural class whose members are produced with a degree of pharyngeal stricture, and therefore satisfies Obrecht's criterion (1968) that "if these sounds are to be considered as members of some single class, then they must possess at least one common feature or common features" (p. 41). The question of whether it is appropriate to treat emphatics as a phonological class can thus be given a straightforward answer. But the claim that emphasis is pharyngealization is not accepted by some linguists such as McCarthy (1994), who as we just saw says that emphasis is not pharyngealization but rather uvularization or Kästner (1981, cited in Laufer and Baer) who argues that pharyngealization is a minor correlate whereas velarization is crucial.

Among the first people who made an explicit mention of pharyngealization are Wallin (1855) and Brücke (1860) (both cited in Laufer and Baer (1988), Jakobson, Fant and Halle (1952), Jakobson (1962), Obrecht (1968) and Delattre (1971), to name a few. Wallin says that the articulation of emphatics is deep in the pharynx and larynx. But it is not made clear how deep the constriction is and what role the larynx could play. He states that the epiglottis falls like a lid and partially closes the larynx. That is probably the earliest experimental description of pharyngealization available, but we have no idea about the type of physiological tool that was used. Brücke studied the activity of the epiglottis in the articulation of alveolar /ṭ/ and uvular /q/. The main problem with his description of pharyngealization, however, is that he reports that the epiglottis completely seals the air-passage, i.e. not partially as reported by Wallin, for example. The pharyngeal constriction which normally accompanies the articulation of emphatics is not so tight that the air-passage is completely obstructed. Laufer and Baer (1988) report that the degree of the constriction is small, and it is considerably smaller than one which is needed for the production of the pharyngeals /ħ/ and /ʕ/. Also, the claim that the epiglottis completely seals the pharyngeal tube contradicts the widely accepted view that multiple articulation involves one primary and one secondary articulation.

Pharyngealization is defined in Jakobson, Fant and Halle (1952) as "a very strong pharyngeal constriction" (p. 34). In Jakobson (1962) it is indicated that the zone where the pharyngeal constriction takes place is the upper pharynx. He might have based his conclusion on Panconcelli-Calzia (1920 and 1921) who is probably the first phonetician to have investigated Arabic and Somali articulations of emphatics using X-ray pictures. The claim that pharyngeal constriction occurs in the upper pharynx implies that Jakobson is giving a closer picture than Wallin's just cited but he does not make mention of the larynx. Obrecht (1968) does not really add that much to what has been reported so far because he merely refers to pharyngeal constriction. In fact, he uses it interchangeably with velarization which could simply imply that he is not quite sure which process is more crucial to the articulation of emphatics. On the other hand, Delattre (1971) had compared the production of the uvulars with that of the pharyngeals using X-ray motion pictures. He found that the uvulars are constricted in the upper pharynx while the pharyngeals are constricted in the lower pharynx (see Fig.(5) below).[17] This distinction is, of course, important for the *tajwid* view which considers emphatics different from pharyngeals due to their point of articulation and possibly their phonological function. It may also imply that Delattre considers

[17] Note that Delattre uses the symbols /ɣ/ and /x/ which correspond to /ʁ/ and /χ/, respectively.

pharyngealization more crucial to the production of emphatics than velarization or other possible activities. To quote his findings, "a pharyngeal articulation is one in which the root of the tongue assumes the shape of a bulge and is drawn back toward the vertical back wall in the pharynx to form a stricture. This radical bulge generally divides the vocal tract into two cavities, one below, extending from the stricture to the glottis, the other above, extending from the stricture to the lips" (p. 129). Note that for /ħ/ and /ʕ/ the constriction is made at and below the level of epiglottis, while for the uvulars it is higher than that point and the tongue root is drawn back so closely against the back wall of the upper pharynx that only a little gap is allowed. The constriction is narrower for the uvular stop than for the uvular fricatives. That could be because a large portion of the tongue back is raised for uvular articulation.

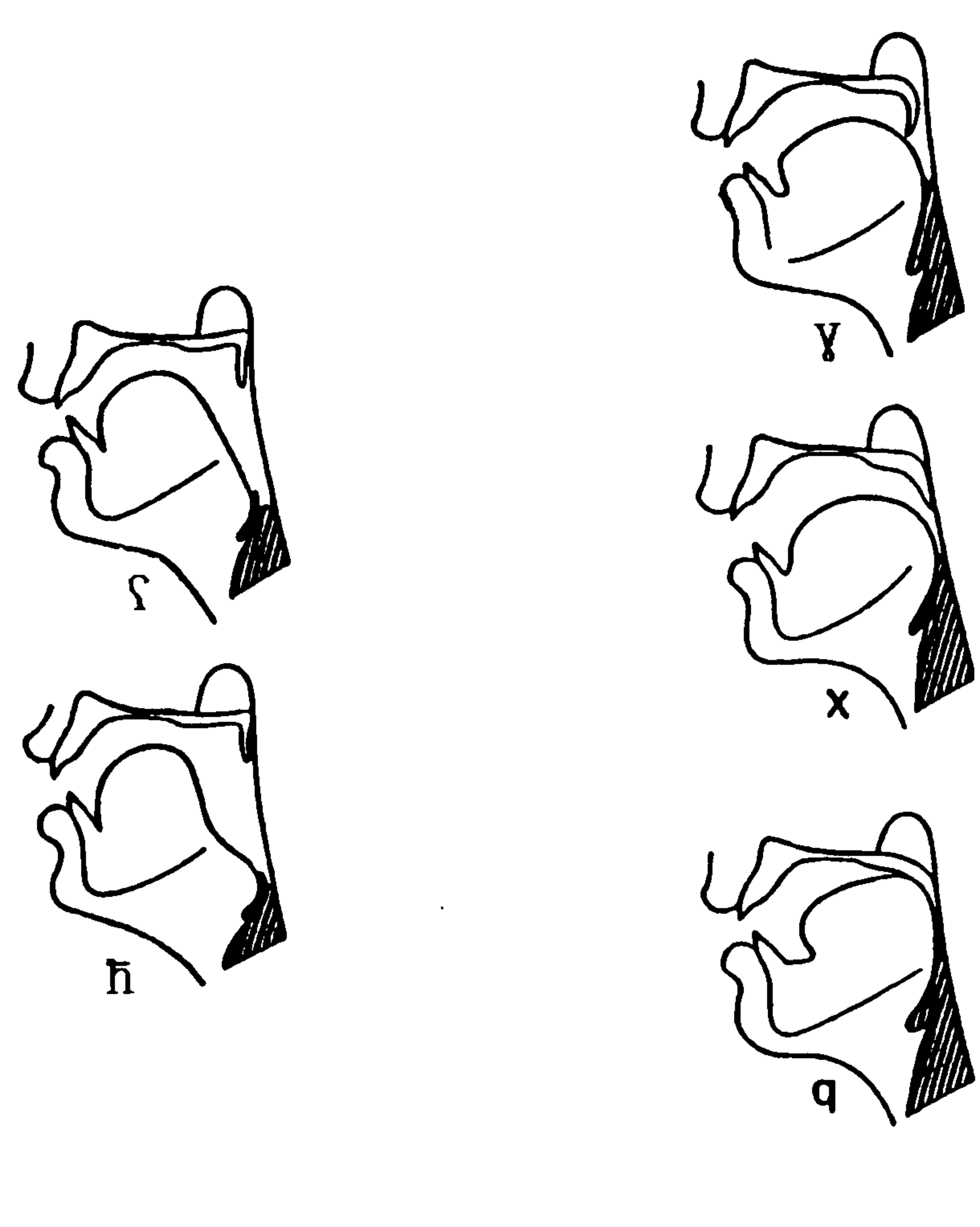

Fig. (5): Region of pharyngeal constriction for Arabic uvulars and pharyngeals
Delattre (1972)

Similar findings are reported by Laufer and Baer (1988) who investigated emphatic and pharyngeal articulation in Hebrew and Arabic using a fiberoptic endoscope and a spectrograph. Unlike Delattre, however, they do not make a distinction between emphatics and pharyngeals as regards their place of constriction in the pharynx. More specifically, they do not make mention of the upper and lower pharynx. They assume that emphatics are characterized by a great deal of variation in the degree of pharyngeal constriction whereas the pharyngeals are highly constricted so that their range of variation in the degree of constriction is pretty small. Ghazeli (1977) similarly argues that the uvulars, emphatic coronals and pharyngeals occur all at approximately the same place and that they are of a comparable width. But he assumes that neither the uvulars nor the emphatic coronals have a laryngo-pharynx which is as constricted as for the pharyngeals. That could match with what Laufer and Baer mention about the degree of pharyngeal constriction which is considerably greater for the pharyngeals.

The above findings are consistent with the premise that pharyngealization is a secondary articulation for emphatics. They may also have significant implications for the assumption that speakers of different dialects tend to show greater variation with emphatics than with pharyngeals. In other words, emphatics could be produced with considerably different articulatory strategies depending on a variety of factors such as style, speech rate, vowel environment and probably the physiological shapes of the vocal tracts of speakers. The question of whether the degree of pharyngeal constriction is the only vocal activity that underlies the difference between emphatics and pharyngeals as argued by Laufer and Baer or whether the place of the stricture along the pharyngeal wall is also crucial to the distinction, as argued by Delattre, may not have a clear answer.

3.3.2.4 Emphasis as multiple articulatory activities

The studies discussed so far focus on a single articulatory activity that is crucial to the production of emphatics and their identification as separate segments: velarization, uvularization or pharyngealization. Theoretically speaking, there may be a small difference between velarization and uvularization and, in general, the claim that emphasis is realized as uvularization is not clearly-defined in the literature. Both velarization and uvularization result from the lowering of the soft palate and the raising of the tongue back, but the point of lingual contact is more posterior for the latter. Both activities differ qualitatively from pharyngealization because the latter involves the tongue root, epiglottis and the pharyngeal wall. Nevertheless, some phoneticians (e.g. Ladefoged 1982) suggest that the difference between velarized and pharyngealized consonants is very small. In other words, the difference between the two mechanisms may be so minor that it is not worthy of dispute and disagreement among phoneticians. If Ladefoged's claim is correct it would become clear why Obrecht (1968) uses the terms velarization and pharyngealization interchangeably and why Kästner (1981) says that pharyngealization is more essential to the production of emphatics than velarization. Accordingly, it is quite possible that emphasis involves more than a single articulatory activity. This point has not drawn the attention of the majority of researchers in spite of its direct relevance to the endless controversy about emphatic articulation. In fact, it appears that Obrecht and Kästner are among the very few phoneticians who hint that emphasis could involve unexplored vocal activities.

But they do not speculate deeply on that. Similarly, Hussain (1990) assumes that the production of emphatics "involves more than pharyngealization" (p. 90). Unfortunately, he does not discuss this conclusion any further or provides experimental justification. ^{c}Umar (1991) argues that emphasis can be regarded as velarization if we consider the vertical movement of the tongue back to produce the sound and it is pharyngealization if we consider its horizontal movement towards the pharyngeal wall. He states that both activities occur simultaneously but like Kästner (1981) never mentions whether one of them is more crucial to emphatic articulation than the other.

Viewing emphasis as a complex of articulatory activities that occur simultaneously (or perhaps successively) dates back to the first quarter of the 20th century when Meinhof (1921) and Panconcelli-Calzia (1924) (both cited in Laufer and Baer 1988) investigated emphatic articulation probably using fiberscopy.

According to Meinhof, emphatic articulation is characterized by three activities:

(i) raising the back of the tongue towards the velum.

(ii) a contraction of the musculature of the hyoid bone.

(iii) lowering of the epiglottis.

Meinhof assumes that the early Arab grammarian Sibawayh (d. 809) did not mention (ii) and (iii) above since he only saw velarization. Presumably Sibawayh had no idea about the hyoid bone or the epiglottis, and certainly not about their function in speech. The traditional interest in velarization is thus justifiable because it was probably far easier to observe the tongue back activities than to recognize the mechanism of the pharynx. However, physiological studies are not always as promising as might be expected. Thus, while Meinhof says the tongue back is raised for the production of the emphatic sound (also reported in Jakobson 1956 and Herzallah 1990) Marçais (1948, cited in Laufer and Baer) argues that the tongue back is lowered. It seems that Marçais is correlating between the lowering of the tongue back and the retraction of the tongue root which results in pharyngeal constriction/narrowing. But we are not quite sure whether it is possible physiologically to make raising and retraction simultaneously or that the retraction must somehow cause the lowering of the tongue back as Ghazeli (1977) proposes. Whatever the case might be, however, Laradi (1983) states that videofluorographic data showed that in addition to the retraction of the tongue root towards the back wall of the pharynx the tongue back is either raised or lowered depending on the adjacent vowel. She also reports that, according to endoscopic observations, the pharyngeal configuration at the level of the epiglottis remains the same while the speaker is producing the vowel.

In addition to three vocal activities mentioned above by Meinhof (1921), Panconcelli-Calzia (1924) makes reference to the raising of the larynx and the constriction of the pharynx due to the actions of the constrictor muscles (she does not name particular muscles). Actually, the raising of the larynx was reported by Wallin (1855) long before Panconcelli-Calzia (see section 3.3.2.3 above). But is the raising of the larynx crucial to emphatic articulation or is it just an automatic result of the tension of the pharynx? If it is crucial, then that should be made explicit in the literature. Apart from the articulatory function of the vocal cords which vibrate during the articulation of some speech sounds, the role of the raising of the larynx in the production of emphatics is not clear. Also, we need to know whether this activity can be observed with all the emphatics, regardless of their primary points of articulation, or can just be noted with one category of emphatics, and not the other. If the raising of the larynx is a physiological consequence of the reduced pharyngeal cavity above the epiglottis (the oropharynx) as reported by Ghazeli (1977), who says that the raising and constriction of the larynx may be used to rush air against the roof of the mouth, that would simply imply that not all the vocal activities that can be observed during the production of emphatics are linguistically important. Actually, Ghazeli mentions that the larynx is raised slightly which could give us the impression that this activity can be shared by other sounds such as velars, or that the raising of the larynx is an accidental activity that may not be observed if physiological studies are made of a larger number of speakers.[18]

El-Halees adopts the view held by Ghazeli (1977) that emphasis is made by depressing of the palatine dorsum of the tongue which is retracted to make a narrowing along the pharyngeal cavity the maximum of which is within the area at the level of the second and third vertebrae. In other words, the contraction is in the upper pharynx. But he further adds five articulatory activities which he calls 'components' (p. 289) and these are:

(i) lowering of the front part of the tongue.

(ii) stretching down of the soft palate (velum).

(iii) narrowing the velo-glossal cavity.

(iv) some lip rounding.

(v) a firmer and narrower contact between the tongue and the roof of the mouth.

[18] Ghazeli (1977) found that there is no upward displacement movement of the larynx during the production of the pharyngeals /ħ/ and /ʕ/. Also, he saw no apparent major displacement of the hyoid bone but it is slightly more back. For both sounds the constriction concentrates in the low pharynx (laryngopharynx).

The relevance of some of the activities mentioned above is not clear, for example how and why the tongue front could be lowered in the production of emphatics. This claim apparently contradicts both empirical evidence and impressionistic judgement about emphatic articulation. The tongue front is raised towards the alveolar ridge for /ṭ, ṣ, ḍ/ or towards the upper teeth for /ð̣/, while it remains neutral for the uvular. This is true particularly with the coronals as reported, for example, by Laradi (1983). She states that there is a firm contact between the sides of the tongue blade (and/or the tongue tip) and the denti-alveolar and post-alveolar region as demonstrated by palatographic studies. Laradi also argues that the tongue tip or blade is slightly retracted (possibly because of the rearward movement of the tongue). Therefore, unless El-Halees is referring to the lowering of the middle of the tongue as illustrated, for example, by O'Connor (1973) in Fig. (6) below, his claim would remain questionable.

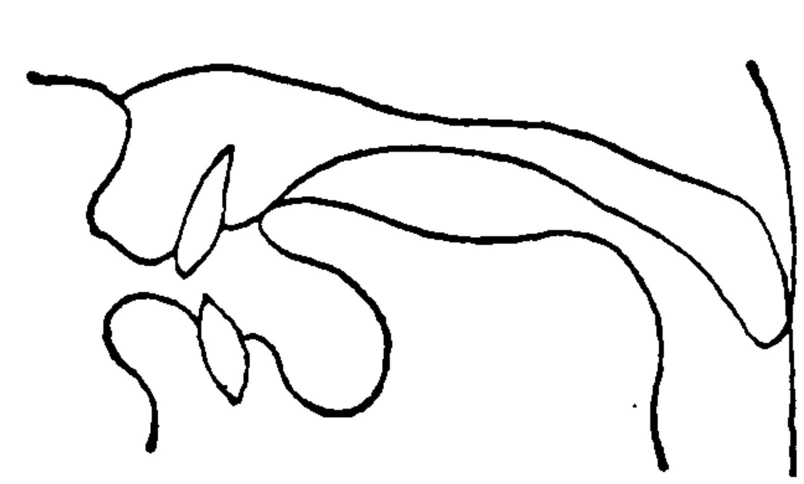

Fig. (6): Tongue configuration in the articulation of an emphatic (dark) /l/
(O'Connor 1973)

The second articulatory activity is the stretching down of the velum. El-Halees might be referring to velarization since the lowering of the velum usually co-occurs with the raising of the back of the tongue unless the velum is lowered to produce a nasal. But why does not he explicitly mention the back of the tongue raising since it would seem to be the active articulator in the production of velarized consonants? This question has two possible answers. First, he could have preferred to draw a fine distinction between the tongue back raising towards the velum (velarization) and the tongue root retraction towards the pharynx (pharyngealization) since his study is not limited to emphatics but it also covers pharynegeals. Recall that some phoneticians (e.g. Kästner 1981) argue that emphasis involves both velarization and pharyngealization. So, he could be referring to velarization by mentioning the passive articulator. Second, it might be possible that the articulation of /ħ/ and /ʕ/ is occasionally associated with nasal airflow as reported by El-Halees. This finding is also reported in Delattre (1971) and Laradi (1983) and Ghazeli (1977). However, it should be noted that this activity may not be possible with the uvulars apparently because the nasal cavity must be shut or obstructed during their articulation.

The narrowing of the velo-glottal cavity could be an implicit reference to pharyngealization. It seems that the muscular tension of the vocal tract, especially the area covering the upper pharynx, the tongue back and the velum, is a major characteristic of emphatic articulation. But that could further imply that it is difficult to ascribe emphatic articulation to a particular organ while ignoring others. That clearly supports the possibility that emphasis is a complex gesture.

One of the good points raised by El-Halees in his description of emphatic articulation is the lip rounding/posture which is usually ignored in the phonetic literature in spite of its possible role in the production of emphatics. El-Halees states there is some lip rounding and Lehn (1963) similarly states that emphatics are associated with slight lip protrusion or rounding (labialization). Harrell (1957) also mentions lip protrusion but he assumes it does not characterize all emphatics. This is, indeed, interesting because the degree of the rounding is variable from one emphatic consonant to another. Impressionistically, the lips are spread for /ṭ/ and /ḍ/ and close-rounded for /ð̣/, for example. So, velarization is not the only articulatory activity that underlies the difference between /ð̣/ and /ð/. The lips remain neutral for the former whereas they are rounded for the latter. Labial rounding is also a possible activity for /ṣ/ but usually the lips remain neutral. As a matter of fact, a few expert reciters make labial rounding when they produce /ṣ/. As for the uvulars, they are produced with open-rounded lips, especially when the speaker wants exaggerates emphasis.

A correlation seems to exist between labialization and emphasis. Delattre (1973) argues that during the articulation of emphatics the anterior oral cavity is relatively large because of the tongue retraction and depression of its palatine dorsum. Following the same line of argument raised by Delattre, labialization may be motivated by the rearward movement of the tongue especially in the case of the uvulars whose production involves a posterior-superior movement of the back of the tongue towards the velo-pharyngeal area (Ghazeli 1977). Accordingly, labial rounding should not be neglected when we discuss emphatic articulation.

The last articulatory correlate mentioned by El-Halees above is the firm contact between the tongue and the roof of the mouth. This description is slightly vague. The roof of the mouth generally stands for both the hard and soft palate and it may also cover the alveolar ridge. El-Dalee might be referring to the tongue posture or configuration in the production of emphatic coronals. This description is similar to the traditional conception *of iṭbāq* 'lidding'. Such an activity is the result of the occurrence of the anterior and posterior vocal activities (note that we are still referring to the coronals) in addition to the overall tension of the musculature of the tongue and pharynx. In other words, apart from the alveolar or dental contact/narrowing with the tongue tip/front El-Halees is indirectly referring to velarization. That again implies that he assumes that emphasis involves multiple articulatory activities. It could also imply that emphatic articulation would remain controversial particularly after we have considered the different articulatory findings about emphasis.

3.3.2.5 Emphatic articulation as sex/age determiner

Laradi (1983) argues that emphatics are generally less prominent in women than in men. She states that "it was found that variations in men and women's speech do exist, especially with reference to pharyngealized consonants" (p. 317). The argument raised by Laradi sheds some light on the problem of articulatory variation which is caused by non-linguistic factors. Emphatics, according to Laradi, are not usually studied with reference to the sex of the speaker for one reason or the other. The majority of phonetic studies were devoted to male speakers while female speakers were not covered. One main disadvantage of that is apparently the elimination of the role of sex in emphatic articulation.

The argument that emphatic articulation varies depending on the sex of the speaker is also raised by Harrell (1957), Kahn (1975), Royal (1985), Maamouri (1967) and Ahmed (1979) (the last two are cited in Laradi). Harrell (1957) states that emphasis can be treated as a stylistic feature. He observed that when segments in Cairene Arabic are made less emphatic by a male speaker, listeners could get the impression that the speaker is imitating delicate women with the way they talk. On the contrary, we expect that increasing or exaggerating emphasis may occasionally express the speaker's manhood or maturity. But these points generally require detailed studies (particularly fieldwork). Certain question will thus arise. If the amount of emphasis has some correlation with the sex of the speaker does that apply to all dialects? Is it true that the socio-economic status of female speakers is also relevant, as Laradi (1983) argues, so that the more educated and wealthy they are the less pharyngealized consonants they tend to produce? Actually, Laradi herself did not investigate this assumption closely and she only used one female speaker in her study (in addition to four male speakers). Besides, she did not investigate emphasis within any particular sociolinguistic framework nor could she explore her own assumptions about the effect of sex and social factors on emphatic articulation. But her arguments are worth consideration and she is not the only phonetician who has been interested in studying the correlation between the production of emphasis and the non-linguistic factors that can dominate it.

Ahmed (1979) similarly argues that the sex of the speaker affects the degree of pharyngealization and that the coronal emphatics provide the most salient differences in pronunciation between men and women (note that her study did not cover the uvulars). She found that in the articulation of female speakers the lips are slightly close-rounded and the tension of the articulatory muscles is relatively small. Therefore, she assumes that women produce a weaker emphasis than men. Maamouri (1967) further mentions children's articulation of emphasis which is similar to that of women. He argues that there exist phonetically varying degrees of emphasis. We think that his comment provides a useful clue to the gradient nature of emphasis which will be directly relevant to our discussions in the following chapters. The variable degrees of emphasis could be a consequence of the employment of different articulatory strategies depending not only on the sex of the speakers but also their age. The sex and age of speakers should be better taken into consideration in physiological, acoustic and sociolinguistic studies of emphasis. That would at least help researchers obtain more comparable results particularly if speakers come from the same sex and age group.

Kahn (1975) compared men's and women's production of emphatics in Cairene Arabic using Arab native speakers and American learners. It was found that women showed significantly less acoustic differentiation between emphatic and non-emphatic segments than men. This finding is consistent with the assumption that men and women do not produce emphatics the same way. But she also found that "while Arab men and women differ significantly in their production of emphatics, American men and women who have been taught Arabic by male speakers are much more similar to each other in the pronunciation of emphatics" (p.38). Kahn used this argument to refute Fant's hypothesis (1966) that formant differences result from the sex of the speaker. In other words, her point is that non-physiological factors must underlie variation in vowel formants for men and women. Her results also cast doubt on Catford's argument (1968) that men and women differ with respect to their articulation of emphatics because of intrinsically physiological and anatomical factors that speakers cannot control. Royal (1985) also studied the same style as Kahn and reached similar conclusions. Differences between men and women as regards the production of emphatics could thus be conventional rather than physiological. That is basically why the American speakers used by Kahn produced emphasis the same way although not all of them were male speakers. Therefore, emphasis is probably a prestigious system for signalling social gender so that the stronger emphasis produced the higher prestige and masculinity the speaker would be expressing. This interpretation of the studies that tackled emphasis from the sociolinguistic point of view matches with Harrell's assumption (1957) above that emphasis can be treated as a stylistic feature. It might also be relevant to the treatment of emphasis in the styles investigated in this study (CA and MSA).

3.3.2.6 Concluding remarks about emphatic articulation

Our review of experimental findings about emphasis in some Arabic dialects makes it clear that it is not easy to give a straightforward objective definition of emphatic articulation. The mechanism underlying emphasis is controversial. Emphasis could be velarization, uvularization or pharyngealization. It could be a combination of these activities or some others in the vocal tract. The attempt to identify one particular articulatory correlate, to the exclusion of others, can thus be misleading. In addition, speakers from different sex/age groups and social background may follow different articulatory strategies to produce emphatics depending on convention and other factors which are not necessarily linguistic. Emphatics may have the same auditory or acoustic effect on listeners but they are not necessarily articulated the same way by all speakers in different social contexts and with all styles. Variation could thus be a major characteristic of emphatic articulation for many possible reasons. This is probably one of the main problems that have led to the disagreement about emphatic articulation in spite of the availability of modern experimental techniques for the study of speech production.

In this thesis we are primarily interested in studying how emphasis does spread or does not spread and what implications that could have for the relationship between phonology and phonetics. Consequently, in view of uncertainty about how emphasis is produced, we will treat emphasis as if it were some sort of uniform phonetic entity and give it the label 'emphasis' accordingly. For the same reasons, we will simply refer to the conventional feature [emph], and we will continue to use a subscript [.] with the symbols that stand for emphatic coronals, rather than a more specific IPA diacritic.

3.3.3 Acoustic correlates of emphasis

3.3.3.1 Emphatics in isolation

The acoustic correlates of emphasis are of a special and direct relevance to the main topic of the present study. In order to tackle the spreading and blocking of emphasis in the styles investigated we need first to discuss the acoustic characteristics of emphasis and decide on the acoustic parameters we are going to use in both the experimental study and the discussion of its implications. The reader will also observe that there is a general tendency among phoneticians to agree on the acoustic correlates of emphasis although that was not the case with emphatic articulation. Harrell (1957) reports that emphatic obstruents (stops and fricatives) are characterized by a lowering in pitch of the noise spectrum, and that there is also a general lowering of the spectrum of resonants. Further detail is given by Al-Ani (1970) and Ghazeli (1977) about individual consonants. As for the stops, Al-Ani found that /ṭ/ appears as a burst in the form of a vertical spike which is stronger than that of its plain counterpart /t/. It is followed by a gap with no noticeable noise. The concentration of the burst is generally lower in frequency than the burst for /t/. The duration of the silence period between the release of the stop and the onsets of the following vowel formants for /ṭ/ is about 20-30 ms. shorter than for the plain counterpart. Al-Ani does not explain why such a difference exists but, according to Ghazeli (1977), the silence period is longer for /t/ because it is aspirated, unlike /ṭ/. Ghazeli also states that the duration of the aspiration itself during the release varies according to utterance length, stress placement and subject/dialect but not according to the present or absence of emphasis. Al-Ani provides no information about /ḍ/ which is pronounced as [ð̣] in the style he investigated (MSA as spoken by Iraqi speakers). But he states that it has the duration of 80-100 ms. Ghazeli similarly does not include /ḍ/ in the speech samples of his study which covered Tunisian, Libyan, Algerian, Cairene, Jordanian and Iraqi dialects. He does not indicate whether this sound is not used in those dialects or whether it was excluded from the study for some reason. We cannot, therefore, give further information about it. But it is expected to share the general acoustic properties of all stop consonants. Al-Ani reports that /q/ appears as a strong burst which is indicated by a vertical spike that starts weakly at the baseline and rises up to 3000 Hz with no noise that follows the spike. His interpretation is that this sound is not aspirated. Ghazeli, on the other hand, gives no account of /q/ although it was included in his physiological study.

In the case of fricatives, Al-Ani (1970) reports that /ṣ/ appears as a random noise with a duration of 100-170 ms. in the upper frequencies of the spectrum starting at approximately 2750 Hz. Ghazeli (1977) similarly reports that the energy concentrates from 3000 Hz and higher and is sometime visible as low as 2600 Hz. According to him, this is also true with the plain counterpart of /ṣ/ (which is /s/). For /ð̣/, Al-Ani states that its duration is about 100-160 ms. and it possesses resonances that appear as weak formants and that both /ð̣/ and /ð/ have the same acoustic correlates. Ghazeli further states that both /ð̣/ and /ð/ exhibit vowel-like formant frequencies and that the two sounds can be distinguished easily by referring to the values of their second formants which are much lower for /ð̣/ than for /ð/. In the case of /x/ (which corresponds to /χ/ in the present study), Al-Ani states that it appears as a random noise whose concentration ranges from 1500-3000 Hz depending on the quality of the adjacent vowel. Ghazeli similarly reports that this sound is characterized by a periodic random noise with the energy ranging from 600-1500 Hz. Al-Ani states that /ɣ/ (corresponding to /ʁ/) appears as a shadow of formant resonances, near the baseline. It sometimes has a very weak noise above the third formant. Ghazeli says that /ɣ/ "is characterized by clear formants with values almost identical for all subjects" (p.59). We think that Al-Ani's description is more straightforward than that of Ghazeli.

The resonance of /ɣ/ results in shaded bands that differ in shape from the random noise that can be seen with /ṣ/, for example. But Al-Ani does not point out that these shaded bands could vary with respect to the degree/intensity of their darkness depending on factors that have not yet been explored in acoustic studies of Arabic such as the speaker's voice quality and the configuration of his vocal tract.

3.3.3.2 Emphatics in vowel context

Several studies of emphasis in Arabic have been based on acoustic measurements (e.g. Al-Ani 1970, Al-Ani and El-Dalee 1984, Card 1983, Bukshaisha 1985, El-Dalee 1984, Hussain 1988 and Herzallah 1990 and El-Halees 1985). They dealt with a variety of Arabic styles, both formal and informal and raised two principal questions:

(i) What are the major acoustic properties of emphasis?

(ii) How far is emphasis manifested acoustically on the vowels? In other words, are all the vowels affected the same way by emphasis and how?

The clearest and probably most significant acoustic property of emphasis is the lowering of the second formant of the adjacent vowel. It is also reported by some investigators that the first formant is slightly raised. Emphatic sounds are characterized by a narrower distance between F1 and F2 than in their non-emphatic cognates (El-Halees 1985). Both formants move towards each other to produce a more compact spectrum than in plain contexts (Ghazeli 1977 and Obrecht 1968). A number of phoneticians (e.g. Card 1983, Herzallah 1990 and El-Dalee 1984), however, have argued that F1 raising is not a reliable or significant correlate assuming that F2 lowering is the only significant acoustic properly that distinguishes emphatics from non-emphatics.

It is very clear that F2 is involved in the acoustic cueing of emphasis. Some studies have found that F1 is involved as well but the results are not consistent. Based on all of this, we decided to use only F2 partly to avoid using a difference measure and be involved in problems of speaker's normalization and so forth. Also, for technical reasons F2 is easier to trace and measure whereas F1 (especially the onset's frequency value) is normally hard to measure. In other words, F2 lowering is easier to quantify acoustically than F1 raising, particularly if we want to avoid complicated transformations of ratios of F2 to F1. As far as emphasis is concerned, F1 could be important and its measurement may lead to useful findings in future studies. It should also be noted that the difference between emphatics and pharyngeals lies in F1 which is considerably higher for the latter class as reported in El-Halees (1985), Butcher and Ahmed (1987) and McCarthy (1994) while F2 is either raised or lowered depending on the quality of the vowel. Phoneticians used F1 and F2 measurements to make predictions about the place of stricture and the configuration of the vocal tract during the articulation of emphatics and pharyngeals. As for F3, El-Dalee (1984) argues that it is the least significant formant because of its inconsistency or fluctuation with regard to emphatic/plain opposition across consonants. It may be used as a separate parameter for distinguishing some segments in the language (Al-Ani and El-Dalee 1984). In other words, it does not seem that F3 is involved in the acoustic cueing of emphasis, but it is probably used for other speech purposes.

We will now consider some acoustic measurements and relate them to the discussion above. Table (2) below (Bukshaisha 1985) shows the mean values of the onsets of the second formants of 8 vowels adjacent to the emphatic vs. plain /ṭ/ and /t/. These vowels can all occur in emphatic environments (they are spoken in Qatari Arabic). The onset of each vowel is lower when it is adjacent to an emphatic

No.	Vowel	t	ṭ	Extent of displacement
1	i	1850	1100	750
2	i:	2250	1100	1150
3	e:	2000	1025	975
4	a	1700	1100	600
5	a:	1300	1100	200
6	u	1500	1000	500
7	u:	1450	750	700
8	o:	1500	1075	425

Table (2): F2 onset mean values of vowels in Qatari Arabic
in the vicinity of /t/ and /ṭ/ (Bukshaisha 1985)

consonant, but the extent of the formant's lowering or displacement is sometimes considerably different. Thus, F2 can be considerably lowered as with /i:/ (1150 Hz) or it can be slightly lowered as with /a:/ (200 Hz). Although Bukshaisha did not analyze the statistical significance of these differences, her data apparently support the view that F2 lowering is crucial to the acoustic cueing of emphasis.

In his study of MSA as spoken by educated Iraqi speakers, Al-Ani (1970), like Bukshaisha (1985) and other phoneticians, reports that F2 lowering is a major characteristic of vowels in emphatic environments. Consider the mean values of some measurements in Table (3). It is true that F2 is lowered in the vicinity of emphatics, but it should be noted that it is also lowered for /s/ which is a plain segment. That could be easily demonstrated by referring to the value of the vowel when it occurs in isolation and compare it to its value when it is in the vicinity of this consonant. Thus, the value of /i(:)/ (2200 Hz) is lowered to approach 2050 Hz for /s/. Similarly, the formant value of the same vowel is lowered to approach 2000 Hz for /k/ and 1600 Hz for /q/. In fact, that may give rise to the argument that F2 lowering is not an acoustic characteristic of emphasis because plain segments could also have it, but this not a convincing argument since the second formant value is not necessarily lowered in all plain environments. In a plain environment such as /s/ with /u(:)/ or /k/ with /a(:)/, for example, the onset is raised. In other words, the lowering of the formant is not always predictable if the consonant is plain. In the case of /u(:)/, Al-Ani's measurements show that the onset is raised from 787 Hz to 1375 Hz because it is following /s/. To this point it becomes clear that we have to distinguish between local acoustic transitions that occur between sound strings and the acoustic parameters that appear to be the result of a rule of spreading.

Vowel	Value in isolation	s	ṣ	k	q
i (:)	2200	2050	1200	2000	1600
a (:)	1350	1450	1162	1450	1175
u (:)	787	1375	920	N.S.E	900

Table (3): F2 onset mean values of MSA vowels in the vicinity of emphatic and plain consonants (Al-Ani 1970)

N.S.E: non-significant effect

Table (4) indicates the main acoustic findings reported by Hussain (1986) in his study of emphasis in Gulf Arabic. What is good about the data is that F1 values are included. Thus, it would be possible for us to go through the first and second formant measurements and see whether it is true that emphasis is characterized by F2 lowering and F1 raising or not. The measurements demonstrate that in emphatic environment F2 lowering is accompanied by F1 raising. But the difference between the measurements for the emphatic coronals /ṭ, ð̣, ṣ/ and their plain counterparts /t, ð, s/ is relatively small (it does not exceede the value difference of 81 Hz for each pair). We will, therefore, go through some of Hussain's measurements of the second formant in Table (5). Let us consider the consonants /ð/ and /ð̣/. (The data is excerpted from Table (4)).

	F1 steady-state						F2 onset						F2 steady-state					
V	t	ṭ	ð	ð̣	s	ṣ	t	ṭ	ð	ð̣	s	ṣ	t	ṭ	ð	ð̣	s	ṣ
i	295	386	345	423	336	415	1926	1245	1976	1260	1826	1210	2094	1490	2260	1577	2173	1479
a	620	643	592	664	578	660	1670	874	1577	1195	1457	1082	1647	986	1663	1170	1611	1195
u	330	362	326	356	336	367	841	853	836	845	817	839	896	860	879	859	880	846
i:	286	317	310	332	320	328	2158	1245	2075	1245	1992	996	2426	2400	2407	2420	2407	2396
a:	670	710	692	747	681	747	1328	913	1062	920	1626	992	1245	996	1306	1079	1404	1062
u:	287	362	305	415	318	360	779	794	789	782	714	742	846	816	849	807	798	765
e:	410	532	426	516	450	526	1826	950	1660	830	1826	747	2324	2020	2241	1992	2253	2075
o:	435	510	455	561	450	530	830	816	856	829	826	795	965	847	920	859	945	830

Table (4): Average values of F1 & F2 in eight vowels in Gulf Arabic emphatic/plain contexts (Hussain1986)

	ð		ð̣	
Vowel	F2 onset	steady-state	F2 Onset	steady-state
i	1976	2260	1260	1577
a	1577	1663	1195	1170
u	836	879	845	859
i:	2075	2407	1245	2420
a:	1062	1306	920	1079
u:	789	849	782	807
e:	1660	2241	830	1992
o:	856	920	829	859

Table (5): F2 onset/steady-state values of Gulf Arabic vowels in the vicinity of /ð/ and /ð̣/ (Hussain 1986)

Most of the measurements in Table (5) above imply that the F2 onset lowering is more marked for /ð̣/ than for /ð/. One plausible explanation for the difference is that because /ð̣/ is an emphatic consonant. The amount of lowering could primarily be a question of phonetic context. But for some reason the lowering of the formant hardly exists with /a/ when it comes next to /ð̣/ in the style investigated. The formant values are 1195 Hz for the onset and 1170 Hz for the steady-state. That contradicts the general agreement among phoneticians (e.g. Ghazeli 1977, El-Dalee 1984 and Al-Ani 1970) that this vowel is significantly affected by emphatics by the lowering of its second formant. It is does not appear that Hussain explored this point which may require physiological investigation. In other words, it could be that the lowering of the second formant of the vowel is affected by the physiological properties of the emphatic consonant which is produced differently in different styles.

So far, it appears that all the vowels are acoustically affected by emphasis. Acoustic studies focus on F2 and consider it more crucial to the acoustic cueing of emphasis than F1. The question is, which vowel is most affected by emphasis? Some phoneticians are apparently interested in classifying the vowels according to what El-Dalee (1984) describes as their strength of frequency distinction. According to him, the ranking of the vowels could be as follows:

(i) /a(:)/ shows the greatest distinction.

(ii) /i(:)/ shows a fair amount of distinction.

(iii) /u(:)/ shows the least distinction, if any.

El-Dalee's taxonomy is also adopted by Al-Ani (1970) and Al-Ani & El-Dalee (1984). Al-Ani states that by comparing the three vowels it can be observed that /a(:)/ is the only vowel which gets both its onset (or offset depending on context) and steady-state lowered because of emphasis. On the other hand, only the vowel's onset is lowered for /i(:)/ which has a high F2 value (approximately 2200 Hz in the style he analyzed). The lowering appears in the form of a sharp formant transition from the onset to the steady-state. So, there is an effect on /i(:)/ but, according to Al-Ani and El-Dalee, it is not as strong as that on /a(:)/. As just noted, they say that /u(:)/ shows the least effect of emphasis.

Although ordering the vowels according to the degree of acoustic effect on them may look tempting it should be noted that it is not necessarily acceptable to all phoneticians. For example, Bukshaisha (1985) thinks that /i(:)/ shows the most dramatic effect among all the vowels she examined. To this point, it is not really clear whether she passed her judgement on the transitions of the formants from one vowel position to another or she used a different criterion. It was stated above that the transition of F2 exhibits sharp lowering, unlike the other two vowels, and that could be one explanation for her hypothesis. In other words, it might be possible that she is interested in the length of the distance through which the second formant proceeds from the onset to the steady-state of the vowel.

3.3.3.3 Perception of emphasis

Two main points emerge from relatively few studies of the perception of emphasis. The first is that F2 lowering is more crucial to the perception of emphasis than F1 raising, and the second is that emphasis is perceived through vowels. The two lines of argument can be thus integrated because they both appreciate the role played by the vowel in speech perception. Below is a brief introduction.

According to Obrecht (1968), the perception of emphasis pertains to the onset frequencies of F2 and also to the transition variations and transition duration. He fixed the frequencies of F1 and F3 and found that F2 is powerful in the perception of emphasis regardless of the phonetic class he examined. El-Dalee (1984), criticizes Obrecht because he did not study the role of the other two formants, although Obrecht himself acknowledges they are also important. We think El-Dalee's criticisms are overstated, as Obrecht appears to have concentrated on F2 for practical reasons alone. In any case, El-Dalee's own analyses of formant measurements showed that F3, in particular, is a non-significant correlate and a less powerful determinant of the acoustic cueing of emphasis.

El-Halees (1984) studied the perception of the pairs /x, ħ/ and /ɣ, ʕ/ in true minimal pairs spoken in Jordanian Arabic.[19] He observed that with raised F1 listeners moved from the uvulars to the pharyngeals. This finding led him to the conclude that F1 raising is crucial to the perception of pharyngeals while F2 lowering is crucial to the perception of uvulars. Similar results are reported by Alwan (1989) who found that F1 is essential in discriminating between /ɣ/ and /ʕ/ (her subjects were speakers of a variety of dialects). She also found that widening the bandwidth of F1 increases the percent of uvular responses and enhances the naturalness of the uvular stimuli, whereas it decreases substantially the number of pharyngeal responses. According to her, increasing the bandwidth of F2 does not affect the percent of identification of the pharyngeal or the naturalness of the synthetic stimuli. This does not only imply that the perception of the sounds involved is enhanced by the transitions of the first two formants, but it also shows that the bandwidth of the formants could be relevant.

Some perceptual studies could have been carried out to tackle theoretical problems that concern phonologists more than phoneticians and they may further call the attention of applied linguists. But since those studies adopt the perceptual approach in the treatment of emphasis it might be useful to discuss them briefly in this section. Alosh (1987) examined a number of hypotheses that pertain to the phonological analysis of Arabic and to foreign language learning, specifically Arabic. He tested the ability of American learners of Arabic to perceive emphasis in order to

[19] El-Halees (1984) calls /x/ and /ɣ/ uvulars but the symbols he actually uses stand for velars.

decide whether the differences observed in the perception in CV sequences are attributable to language proficiency, to the segments themselves or to both. He used normal CV and cross-spliced sequences where a plain consonant was combined with an emphatic vowel or the other way round. He found that the Arab and American subjects employed different perceptual strategies. The Arab subjects were more sensitive to emphasis either on the vowel or on the consonant. On the other hand, the American subjects were much more sensitive to emphasis on the vowel than on the consonants. We assume that the Arab subjects were more sensitive to emphasis on the consonant because Arabic has a number of emphatic consonants unlike American English. That is probably why Harrell (1957) comments that "it is a heroic achievement for most English speakers to hear the emphatic and non-emphatic consonants as such" (p. 70). In other words, English speakers who do not speak Arabic or some other languages that have emphatics do not usually hear the difference between, say, /t/ and /ṭ/ as in *tīn* 'figs' and *ṭīn* 'mud'.

Ali and Daniloff (1974), on the other hand, attempted to answer the question of whether native speakers of Iraqi Arabic would be able to identify the presence or absence of an emphatic class of consonants /ṃ, ð̣, ṣ, ṭ, ḳ/. They used speech materials consisting of 14 pairs of meaningful Arabic utterances contrasting in a single consonant and tape-spliced the emphatic/plain consonants from the utterances. Most of their listeners were apparently able to identify the words in spite of the missing consonants. But it was also found that the amount of emphasis put on a consonant was quite relevant to the amount of emphatic coarticulation produced by a given speaker and, consequently, the perception of emphasis was affected. Therefore, they recommended a more systematic study to reveal in what way phonetic context affects the perception of emphasis. The study supported the view that coarticulatory effects are not only important for speech perception but also that "a naturally coarticulated stream of segments provides for naturalness in the perceived quality of speech. Inability to specify coarticulation effects probably contributes to the rather unnatural quality of synthetic speech" (p. 229).

An interesting point raised by Ali and Daniloff is their observation that the vowel occurring in emphatic environment plays a significant role in the perception of emphasis. But it is not clear whether they used this finding to support any theoretical claims about the source of emphasis. Their finding that the amount of emphasis is crucial to its perception indirectly shows that emphasis is a gradient feature (see Chapter Five). More specifically, it shows that a successful perception of emphasis is indirectly dependent on the amount of emphasis which listeners are exposed to. Accordingly, it is quite possible that emphasis can be conceived as a continuous scale of vowels which are coloured with gradual degrees of emphasis.

3.3.3.4 Remarks about the acoustic properties of emphatics

So far, we have good reason to think that the acoustic analysis of emphasis is best done by studying the measurements of the second formant of the vowel occurring in emphatic context. Perceptual studies have shown that the vowels are also essential to the perception of emphasis and that F2 is a useful clue to the acoustic analysis of emphatics. We adopt the view that the lowering of the second formant is much clearer than the raising of the first formant. Indeed, among the first three formants of the vowel F2 is apparently the easiest and most straightforward parameter to measure and analyze acoustically. That will also help us avoid complicated transformations of ratios of F2 and F1. It is a simple variable to handle and it will help us avoid normalization problems as well. We do not fully understand the connection of F1 to emphasis. So, this problem will remain open to further investigation. But our selection of F2 is at least consistent with other investigators' selection of the same parameter in their study of certain phenomena such as coarticulation resistance (Bladon and Al-Bamerni 1976).

3.3.4 Emphatic Coarticulation

3.3.4.1 Difference between coarticulation and spreading

Our purpose in this section is not to discuss theoretical problems related to the definitions of 'assimilation', 'coarticulation' and 'spreading' in current literature where the three terms are sometimes used interchangeably. But since these terms are used in the present study might be appropriate to shed some light on their scope.

Part of the answer to the question about the difference between coarticulation and spreading lies in the issue of the phonology-phonetics interface which will be addressed in Chapter Five in greater detail. Keating (1990), for example, assumes that certain phenomena which are clearly phonetic are often given unsatisfactory phonological treatments, and she gives emphatic coarticulation as an example. She adapts the term 'phonological coarticulation' as opposed to 'phonetic coarticulation' and states that coarticulation could sometimes be part of the grammar like the spreading of features. Hammarberg (1976) similarly mentions briefly coarticulation rules which have been disregarded mistakenly in *SPE* and subsequent works. His comment is that "coarticulation rules may be viewed simply as assimilation rules, and they would thus be no different, in essence, from other kinds of context-sensitive phonological rules" (p. 362). Similar comments are given by Pierrehumbert and Beckman (1988) in their treatment of tone in Japanese. So, the main difference between assimilation rules, such as the spreading of phonological features, and coarticulation rules is that featural spreading refers to symbolic and abstract elements of speech production whereas grammatical coarticulation is to be attributed to physical and quantitative data that cannot be excluded from the grammar because they are language-specific. Both types of rules (spreading and coarticulation) essentially belong to the grammatical component of language (Hammarberg 1976).

Thus, we may want to differentiate not only between assimilation and coarticulation but also between spreading and coarticulation. In this study, we will deal with emphatic spreading as a phonological rule and the same principle will apply to discussions that will be presented under the heading 'emphatic assimilation'. As for emphatic coarticulation, we will use the term in accordance with the current trend (e.g. Keating 1988 and Cohn 1990) which attributes some coarticulatory 'low-level' processes to the grammar. But we will also make it clear that emphatic coarticulation could also be mechanical in some cases. Basically, the question whether emphatic coarticulation is grammatical or mechanical has no clear answer. Unfortunately, few studies have so far tackled this important issue and that will definitely leave some problems unresolved.

3.3.4.2 Emphatic coarticulation: a problem for linguistic analysis

Emphatic coarticulation in Arabic is a problem in current literature because it is not quite clear whether it is dictated by the bio-mechanical demands and physiological requirements of the speech mechanism or rather by the employment of rules that underlie the mutual effects between neighbouring sound strings. Our purpose in this section is, therefore, to shed light on some views regarding the place of emphatic coarticulation in the phonetics or in the phonology so that we can have a clear idea about the main issues that will be brought into light in the remaining chapters.

Generally speaking, the studies that have dealt with emphatic coarticulation raised three principal questions and tackled them either from a phonetic perspective or from a phonological perspective. Those studies, however, have left a number of problems unresolved. The questions are:

(i) Do all emphatics affect adjacent consonants and vowels similarly or is the effect variable from one sound/context to another?

(ii) How far can the emphatic gesture extend to affect the articulatory properties of neighbouring sounds whether in single words or across word-boundaries?

(iii) Is emphatic coarticulation to be attributed to bio-mechanical demands of the speech organs or is it governed by language-specific rules?

There is a general tendency among phoneticians and phonologists (e.g. Harrell 1957, Ghazeli 1977, Laradi 1983, Ali and Daniloff 1972, Herzallah 1990, Card 1983, Hoberman 1989 and El-Dalee 1984) to assume that emphatics induce their coarticulatory effects in adjacent segments. Harrell (1957), for example, indicates that most non-emphatic consonants in the phonemic inventory of Egyptian Arabic may be turned into emphatic as in *ṭīn* /ṭi:n/ 'mud', *shahr* /ʃahr/ 'month' and *fukhkhār* /fuχχa:r/ 'pottery'. In these utterances the effect can be observed regardless of the position of the emphatic consonant (initial [ṭ], final [ṛ] and mid [χ]). In Hejazi Arabic, plain consonants such as /s/ and /t/ are more susceptible to emphatic coarticulation as in *basaṭṭa* /bəsəṭṭə/ '(you) spread'; pronounced [baṣaṭṭa], and *aṣwāt* /ʔəṣwæt/ 'sounds'; pronounced [ʔaṣwa:ṭ]. Coarticulatory emphasis may be partly explained in terms of the speaker's desire to save articulatory effort by smoothing out the transitions between segments. Thus, in *aṣwāt* above the speaker may find it easier and even more economic to keep the emphatic gesture operating throughout the whole utterance than to shift abruptly from an emphatic gesture to a plain gesture in the same utterance during a short period of time so as to produce two contradictory adjacent gestures.

The study of emphatic effects on vowels has received more attention than their effects on consonants. According to Ghazeli (1977) who studied emphatic coarticulation using both acoustic and cinefluorographic analyses, there is no obvious way of determining the extent of the effect on consonants from their acoustic spectra alone. Apart from nasals and liquids, which generally manifest the effect in the lowering of their F2, emphatic effects on other consonants can only be inferred from the transitions of the vowels preceding or following them. We further think that part of the problem lies in the complex nature of the emphatic gesture itself. It was seen in section 3.3.2 that it is still not quite clear how emphatics are produced. There may be more than one back articulator involved in emphatic articulation. Generally speaking, however, since the vowels exhibit formants on spectrographic data, their acoustic properties could probably help providing a clear picture of some aspects of emphatic coarticulation. In other words, it will be possible to investigate the coarticulatory effects of emphatics on the vowels by studying their F2 measurements.

Since vowels have different articulatory properties they do not exhibit the same amount/degree of emphasis. To this point, it should be made clear that a phonetic interpretation of emphatic coarticulation should not be confused with a phonological interpretation of emphatic spreading. Some phonologists fail to keep the two interpretations separate. For example, Card (1983), like the *tajwid* scholars, states that emphasis spreads to low vowels only (i.e. /a(:)/). But she confuses this phonological approach with the phonetic effects of emphatics on /i(:)/ and /u(:)/ by stating that /i(:)/ is not affected by a preceding emphatic consonant "although a centralized offglide may be heard in passing from the emphatic consonant to /i:/" (p. 30). For /u(:)/, she says that this vowel has a very low F2 that cannot be lowered further, but does not block emphatic spreading. Accordingly, she concludes that both vowels are not affected by neighbouring emphatics. We argue that her assumptions are not accurate from a purely phonetic perceptive. In fact, it was indicated in previous discussions that even the early *tajwid* scholars postulate that all the vowels are phonetically affected by neighbouring emphatics. The question whether the articulatory and acoustic affects of emphatics on the vowels could be regarded as the result of phonological rules should be separated from what actually happens when low-level phonetic effects are realized. Herzallah (1990) observed the difference between the two approaches, the phonetic and the phonological. She reports that a low-level effect on /i(:)/ and /u(:)/ is certain but emphatic spreading, as a phonological rule, is only reserved for /a(:)/. This separation between what is abstract and what is physical could also be relevant to perceptual studies of emphasis. Recall that Ali and Daniloff (1974) asked their listeners to identify a set of words containing different vowels after they have tape-spliced the emphatics that immediately preceded the vowels. The majority of listeners were able to identify the words unmistakably even without the missing emphatic consonants. This clearly implies that all the vowels must fall under the coarticulatory effects of emphatics. Yet, it is quite possible that the non-low vowels (e.g. /i(:)/) exhibit a smaller amount of emphasis if compared to /a(:)/, for example.

The difference between the phonetic outputs of the different vowels in emphatic environments may be primarily affected by their own articulatory properties. For example, El-Dalee argues that the volume of the oral cavity is wider for /a(:)/. Accordingly, he assumes that there is an articulatory symmetry between this vowel and emphatics in the sense that they both share an open oral cavity and a constricted pharynx. His claim is that /a(:)/ is so susceptible to emphatic coarticulation that it is usually more apt to assume environmental effects than the other vowels when they occur in emphatic context. El-Dalee's claims probably point to a phonetic reading of emphatic coarticulation in Arabic. He clearly rules out the possibility that emphatic coatculation is the output of the grammar.

Herzallah (1990) and Delattre (1971) similarly state that /a(:)/ is produced with pharyngeal constriction which implies it is similar to emphatics in some respects. The main point in the above arguments is that /a(:)/ exhibits more emphasis than the other vowels. But it should also be pointed out that the neutrality of /a(:)/ (as El-Dalee describes it when he compares it to the other vowels as regards the tongue position and height) may not be taken to indicate that this vowel would always coarticulated with emphasis. For example, Ghazeli (1977) argues that the long vowel duration in *bāqi* [bæqi] 'remaining' and *lsāq* [lsæq] 'glue' in Tunisian Arabic prevents the coarticulatory effect of the following uvular (emphatic) consonant and it probably helps /a/ to retain its plainness. His hypothesis is that during the articulation of this vowel the articulators are given enough time to reach their phonetic target before they move into the uvular place of articulation. Actually, that could give the indication that Ghazeli is describing a language-specific rule which may not be attested in other dialects. Therefore, the main issue is that emphatic coarticulation cannot always be explained in purely mechanical terms. Unfortunately, Ghazeli did not explore the implications of his observations for the place of emphatic coarticulation in the grammar.

There is a general agreement among phoneticians that all the vowels fall under the coarticulatory effects of neighbouring emphatics and that the effects vary from one vowel to another. It is also generally assumed that the effect is clearer on /a(:)/ than on the other vowels. The nine phonetic symbols shown in Fig. (7) below are used in some articulatory and acoustic studies of emphasis in Arabic (e.g. Ghazeli 1977 and El-Dalee 1984). The three symbols standing for the long allophones of /a:/ are [ɛ:, æ, ɑ:]. The first of these represents *imālah* 'inclination' (sometimes described as the fronting of the tongue) which is rare in the recitation model examined in the present study. The other two symbols stand for plain and emphatic allophones of /a:/, respectively. Their short plain counterparts are represented by [ə] and [ɑ]. No distinct symbols are used to distinguish the allophones of the remaining vowels, but that does not mean that they are not phonologically distinguishable.

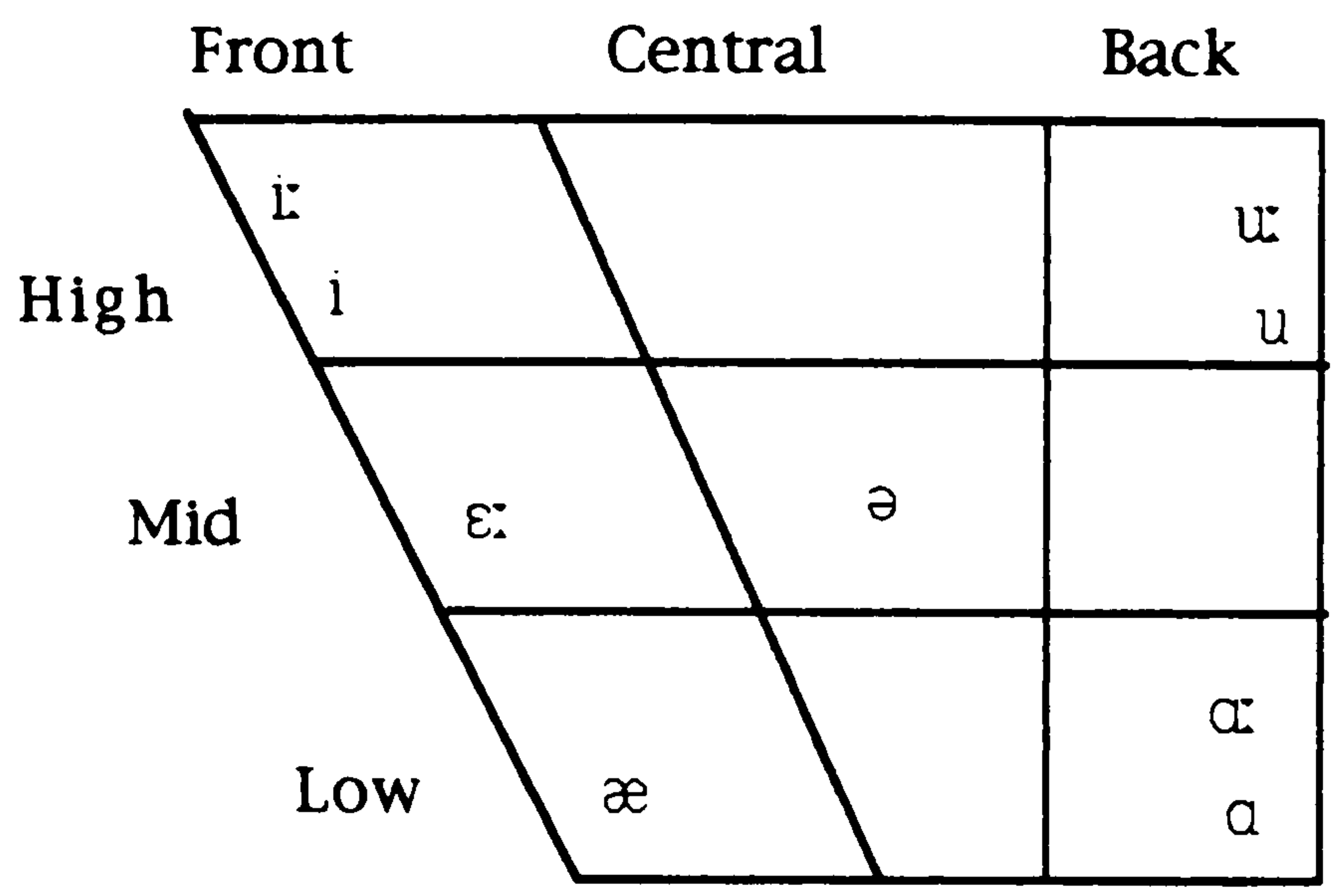

Fig (7): Vowel qualities in emphatic/plain environments

Certain points are still to be mentioned. It is claimed by Ghazeli (1977) that the uvulars have a shorter coarticulatory effect than the other emphatics. According to him, a post-uvular /a(:)/ does not require an extra articulatory effort but only the lowering of the tongue back after the lingual contact is released. "Mechanico-inertial and timing factors make the vowel an easier target" (p. 62). This is an explicit mechanical interpretation of the coarticulatory effect of the consonant on the vowel. So, what the speaker merely has to do in order produce an emphatic vowel is to release the uvular closure. But is it a physiological necessity that the vowel must get emphasized in a uvular environment in all dialects? As it was stated before, Ghazeli himself found that in Cairene Arabic it is not. Part of the problem, I think, is that emphatic coarticulation is not consistent among all dialects. Table (6) below (adopted from Ghazeli with some modifications) shows F1 and F2 mean value measurements of /a:/ in five Arabic dialects. Note that in Cairene Arabic the values are the same for the uvulars and plain consonants and, similarly, in Tunisian the values did not show significant differences. But compare the measurements of Cairene to those of Tripoli Libyan Arabic. While there appears to exist no significant difference with the coronal emphatics the uvulars show a difference value of 450 Hz which is presumably significant. Therefore, we still think that the mechanical approach to emphatic coarticulation is not entirely adequate for giving a consistent picture about the grammatical behaviour of emphatics.

Category	Tunisian		Tripoli Libyan		Zaouia Libyan		Jordanian		Cairene	
	F1	F2	F1	F2	F1	F2	F1	F2	F1	F2
Uvulars	600	1500	600	1450	650	1350	700	1300	450	1900
Emphatic Coronals	600	1300	600	1150	650	1250	700	1200	650	1250
Plain seg.	500	1600	500	1600	500	1600	700	1500	450	1900

Table (6): F1 and F2 mean value measurements of /a:/ in a variety of Arabic dialects (Ghazeli 1977)

By comparing the measurement values of the uvulars and emphatic coronals in Table (6) above it can be observed that the second formant values are constantly lower for the emphatic coronals. The reason may be attributed to their complex articulatory mechanism which involves a secondary articulation in the back of the oral cavity. Ghazeli (1977) assumes that the emphatic coronals have a larger coarticulatory scope than the uvulars because of the secondary articulation. According to him, unlike the uvulars which involve a single articulatory activity, the back of the tongue raised for the coronals as a secondary articulation is not released immediately and simultaneously with the tongue tip/blade. That is, the tongue back lowering for the coronals is slower than for the uvulars. Similar explanations are given by Bukshaisha (1985), Ali and Daniloff (1972) and Hussain (1986). It is generally assumed that once the primary articulation is dissolved for the production of an emphatic coronal the secondary articulation usually lasts for a longer time because the tongue back is not as briskly mobile as the tongue tip/blade (Bukshaisha 1985). That is why the effect of the coronals is large enough to influence an entire word or even cross word-boundaries to affect neighbouring words.

Although the above assumptions about the weak coarticulation effects of the uvulars are plausible they could also be misleading. Impressionistically, speakers of Kuwaiti dialect, for example, are well known for producing words that contain uvulars but are nevertheless entirely emphatic. For example, in *qiyādah* 'leadership', *al-khāmsah* 'the fifth', *waqtah* 'his time' and *al-khilāfāt* 'disputes' the coarticulatory effects of /q/ and /χ/ proceed to cover all the syllables. In other words, the uvulars in this particular dialect do not differ significantly from emphatic coronals. It is not clear why this should be the case. Further investigation may shed more light on this phenomenon. But the main point to raise here is that it may not be entirely true that the uvulars have a shorter coarticulatory domain than the emphatic coronals in all the dialects of Arabic.

The final question to consider is the place of emphatic coarticulation in the grammar. It was argued above that the biomechanical approach could fail to show why certain sounds, such as pre-emphatic /a:/ in Tunisian Arabic (Ghazeli 1977), do not exhibit emphasis. We will now discuss some views about emphatic coarticulation and make some predictions about them. Ghazeli (1977) states that emphatic coarticulation in most Arabic dialects cannot be attributed to mechanical demands on tongue movements but it is pre-programmed for the entire word. He claims that the emphatic gesture can extend over an entire word but will not extend 15 ms. across the word-boundary. Thus, in a word ending with an emphatic consonant anticipatory coarticulation will colour all the segments preceding the emphatic consonant with emphasis, but the initial consonants of the following word will not be affected regardless of its susceptibility to emphasis. Similarly, a word containing an initial emphatic consonant will be entirely emphatic, but the last segment in the preceding word will remain plain. In other words, the effect cannot proceeding further beyond the word-boundaries even when the two neighbouring words are produced without pause. Ghazeli speculates that since emphatic coarticulation is constrained to single words and it vanishes across word-boundaries this phenomenon cannot be considered mechanical but must be phonological. Similar comments are made by Ali and Daniloff (1972) who assume that the coarticulatory effects of emphatics are centrally programmed at a very high level. Hussain (1986) also states that the emphatic gesture is organized to occur over some periods of time, not in an instant of time. He says that this gesture is time-locked to the remainder of the articulatory activity. The time-locking is not universal and could vary from one dialect to another or even among the speakers of the same dialect. But Hussain was apparently unable to examine these assumptions closely in spite of their potential significance for the question whether emphatic coarticulation could belong to the individual grammars of Arabic styles. The above studies of emphatic coarticulation may be implicitly describing language-specific rules that underlie the domain of the emphatic spread. They are also consistent with the notion that the temporal structure of coarticulation is pre-planned (Wood

1995). Contrary to them, however, Bukshaisha (1985) states that emphatic coarticulation is a low-level phenomenon. According to her, Ghazeli's assumption that emphatic coarticulation is constrained to the word containing the emphatic consonant(s) is inaccurate (note that Ghazeli explicitly says that emphatic coarticulation in most dialects is not mechanical). In her study of Qatari Arabic, she found that in [haṭ ismi] 'he listed my name', for example, the F2 value of the initial [i] of [ismi] gets lowered from 1700 Hz to 1250 Hz. Also, the duration of the vowel is 30 ms. longer than that of the final [i]. Her explanation for the difference between the vowel durations is that the initial vowel must have been affected by the preceding emphatic consonant across the word-boundary. She argues that the production of emphatic requires a relatively longer time than non-emphatics, and she appears to correlate between that and the long duration of the post-emphatic [i]. But she does not seem to have considered that the difference could also be attributed to other factors such as the position of each vowel in the utterance or the placement of the primary stress on the first vowel in [ismi].

Bukshaisha also found that in [be:t ta:jir] 'trader's house' [e:] has its F2 value as high as 1800 Hz but it drops to 1500 Hz in [be:t ṭ:ajin] 'kitchen'. Similarly, in [bas bisi:r] 'but he is walking' the F2 of [a] has the value of 1500 Hz but it drops to 1250 Hz in [bas biṣi:r] 'but it is possible'. Both examples demonstrate that anticipatory effects of emphatics can extend across word-boundaries like perseverative effects. Bukshaisha assumes that the effect of emphatics can extend to a maximum distance of about 600 ms. before and/or after producing the emphatic consonant or as many as 6 segments ahead of the emphatic consonant. Thus, in [ṣa:matla] (it could be a nonsense word) the F2 values of the sounds following /ṣ/ indicate they exhibit emphasis. But the amount of emphasis is dependent on the distance between the trigger and target segments. Thus, the F2 value of /a:/ drops from 1250 Hz to 1000 Hz whereas that of the final vowel drops from 1500 Hz to 1400 Hz. In other words, by progressing away from /ṣ/ the influence of emphasis gradually weakens until it completely fades away. Bukshaisha concludes that anticipatory emphatic coarticulation is not deliberately programmed/controlled by a high level articulatory mechanism and that the low level mechano-inertial constraints of perseverative coarticulation are caused by sluggish/slow response of the articulators (Ali and Daniloff 1972). She further rejects the view that certain sounds, such as /i:/ and /ʃ/, restrain emphatic coarticulation because they involve an articulatory activity which is intrinsically contradictory to the one of emphatics. Her main argument is that emphatic coarticulation is the result of a low level articulatory control mechanism. What is involved here is just a complex vocal activity which requires the articulators to move slowly. Thus, in a word containing a mid emphatic consonant the emphatic gesture is not achieved suddenly but only gradually and once it is produced it is not terminated suddenly either. Unlike the primary stricture which is dissolved first, the secondary articulation lasts for some time until it fades away. Bukshaisha states that emphasis increases by moving towards the emphatic consonant and it decreases by moving away from it regardless of syllable or word-boundaries. She makes it explicit that she does not agree with Ghazeli (1977) and other phoneticians who argue that emphatic coarticulation is not a mechanical process.

Bukshaisha fails to account for several problems that she leaves unresolved. She reports that the coarticulatory effects of emphatics can extend to a maximum distance of 600 ms. (or 6 segments) in both directions and that the effect of emphatics constantly follows a gradual pattern. Therefore, she concludes that emphatic coarticulation is a purely mechanical process. But that could be taken to imply that at least some emphatic coarticulation processes are language-specific not universal. Also, if emphatic coarticulation is universal, as Bukshaisha claims, then why is not it consistent among all Arabic dialects? Unfortunately, she does not speculate on these assumptions nor she attempts to give a satisfactory explanation to her claim that the gradual falling/raising of the second formant of the vowel is indicative of a purely mechanical process. Phonologists (e.g. Davis 1993 and Hoberman 1989) report that dialects differ greatly in this respect and that the chief problem with emphasis is to predict the extent of its effects on adjacent segments. Therefore, it does not appear that the phonetics alone can solve this problem. Ghazeli's (1977) finding (which was not reported by Bukshaisha) that in Tunisian Arabic a pre-emphatic /a:/ is constantly plain unlike in other dialects cannot apparently be explained in purely mechanical terms. It was indicated above that Ghazeli proposes that the long duration of the vowel could be crucial to its plainness and that the tongue is given enough time to retain its forward position before it assumes the configuration required for producing the following emphatic sound. So, is that a mechanical or grammatical behaviour? Why is it that this particular phonetic behaviour is not attested in the remaining dialects of Arabic although emphatics would presumably affect adjacent non-emphatics? It does not seem that Bukshaisha (and maybe Ghazeli) attempted to explore the answers to this and some other relevant questions. [20]

The assumptions that emphatic coarticulation is mechanical and universal may thus ultimately lead to incorrect predictions about the grammatical function of emphasis. However, further investigation is required before final conclusions could be drawn. The exclusion of emphatic coarticulation from Arabic phonology, as done by Bukshaisha, is similar to what was done by Chomsky and Halle in their study of the sound pattern of English. They decided to draw a sharp dichotomy between phonology and phonetics and considered all coarticulatory processes separate from the grammar. It is stated in this study that the *SPE* model appears to be inaccurate in this respect. Emphatic coarticulation may be the output of a language-specific rule. The data analyzed in this study will help us explore the arguments and problems raised so far in this review.

3.3.5 Summary of emphasis in modern phonetics

The previous sections have discussed studies of emphasis in modern phonetics. We started with the number of emphatics and stated that Arabic dialects show a considerable variability in this respect. Not all the dialects use the same number of emphatics and the same emphatic consonant may be articulated differently in various dialects. Therefore, it is not possible to make a straightforward conclusion about the number of emphatics in Arabic. It was also indicated that some phoneticians and phonologists prefer not to include the uvulars under the class of emphatics. We saw

[20] It will be indicated later that some phonologists (Card 1983) assume that emphatic spreading is blocked by segments involving a contradictory tongue configuration to that of emphatics.

later that the domain of emphatic coarticulation may be relevant to their approach because it is sometimes assumed that the uvulars have weaker coarticulatory effects on adjacent segments than the emphatic coronals.

We discussed emphatic articulation and explicitly showed that experimental phonetics, in spite of the availability of modern physiological equipment, is still far from a clear understanding of the production of emphatics. Dialectal variation in addition to differences in the sex, age and social background of speakers are all relevant to the problem. Emphatic articulation is apparently a complex phenomenon that may involve velarization, uvularization, pharyngealization or other activities some of which may still unexplored. We have therefore decided to continue to use the conventional covering label 'emphasis' and treat it as a uniform phonetic identity.

Since this study is primarily acoustic it was essential to shed some light on the acoustic properties of emphasis as reported in the literature. The acoustic properties of vowels in emphatic environment show that the transitions of both the first and second formants are affected, with F1 invariably raised and F2 invariably lowered. However, the lowering of the second formant is much more salient. Therefore, it was decided to measure F2 frequency values of /a/ in the experimental study and avoid problems in dealing with data based on both F2 and F1.

We finally discussed emphatic coarticulation and attempted to seek information about how far different sounds may fall under the influence of emphatics and also how far the effect can extend over several syllables in both directions. The descriptions reviewed demonstrate that the effect is undeniable. But it appears that the different properties of the target segments are crucial to the extent of the coarticulatory effects of the trigger segments. The vowels are all affected, but it seems that /a(:)/ is more affected than the other vowels, possibly because its articulation is somewhat similar to that of emphatics or perhaps because it can show more variability than the other vowels. These assumptions are consistent with the traditional accounts which show that /a(:)/ exhibits a large amount of emphasis. However, neither *tajwid* scholars nor modern phoneticians would accept the view that vowels other than /a(:)/ are never affected phonetically by nearby emphatics. Some phonologists (e.g. Card 1983) have confused the phonology with the phonetics by claiming that only /a(:)/ exhibits emphasis. We argued that standard feature spreading models, whether classical or modern, assume that only /a(:)/ exhibits emphasis categorically. But that does not necessarily entail that low-level phonetic coarticulatory effects are not realized on the other vowels. Moreover, the low-level emphatic coarticulatory effects on /i(:)/ and /u(:)/, no matter how small the effects are, could well be crucial to the perception of the coarticulating emphatic consonants. That is basically why both *tajwid* scholars and modern phoneticians assume that all the vowels are phonetically emphatic in the vicinity of emphatic consonants but differ in the amount of emphasis.

There is general agreement among phoneticians that the emphatic coronals induce a larger coarticulatory effects on neighbouring sounds than the uvulars. That could be a reason why some investigators have excluded the uvulars from the class of emphatics or regarded them as secondary. It might be true that the difference between the coarticulatory domain of both groups of sounds is better attributed to the physiological nature of the emphatic coronals which involve both primary and secondary articulations. But in certain dialects (e.g. Kuwaiti Arabic) the uvulars may not differ from the coronals as regards the domain of emphatic coarticulation.

Finally, whether to attribute emphatic coarticulation to the phonology or to the phonetics is a challenging problem. Some phoneticians (e.g. Ghazeli 1977, Ali and Daniloff 1972 and Hussain 1986) have suggested that emphatic coarticulation may be in certain cases language-specific and not universal. But none of them speculated more deeply on that, nor did they discuss this problem within a broader theoretical framework. On the other hand, Bukshaisha (1985) argues that emphatic coarticulation is purely mechanical. Her evidence for that is the gradualness of the coarticulatory effects which increase or decrease by preceding towards or away from the trigger segment in addition to the occurrence of emphatic coarticulation across word-boundaries. We have argued that her own data and the studies she cites (especially Ghazeli 1977) are not very consistent with her conclusions. The following section discusses the status of emphasis in both traditional and modern phonologies, and sheds some light on three major problems in the literature: the distinctive feature analysis of emphasis, the source of emphasis in an utterance, and the spreading/blocking of emphasis. By presenting some of the phonological problems related to emphasis we will hopefully get a clearer picture of the place of emphasis in the linguistic grammar.

3.4 Emphasis in *tajwid* phonology

3.4.1 Distinctive feature analysis of emphasis

Recall that the emphatic coronals and gutturals are traditionally specified for [*musta*^{c}*lī*] 'elevated' and that the former are further specified for [*muṭbaq*] 'lidded/velarized' (Chapter Two). It appears that the majority of *tajwid* scholars include all the emphatics under the former feature. In other words, the emphatic coronals and gutturals are treated as a natural class in *tajwid* tradition because they share the phonetic property of the tongue back raising.

An important point to consider is that we should not limit our understanding of the features [*musta^{c}lī*] 'elevated' and [*muṭbaq*] 'lidded/velarized' to their mere phonetic connotations. Previously, we speculated that the gutturals might have been excluded by some early scholars from the class of emphatics because they lack specific articulatory or auditory correlates which are present in the production of the coronals. But the exclusion of the former may also mean that they do not function phonologically or morphologically the same way. Unfortunately, this problem is not tackled in the *tajwid* works that we went through. That could imply that some grammatical problems in CA do not fall within the domain of the *tajwid* theory. However, further studies of feature analysis of CA segments may lead to interesting findings about this problem.

3.4.2 Spreading of emphasis and its source

It was indicated in the preceding discussions of emphasis in *tajwid* and modern phonetics that emphatics tend to affect neighbouring segments. Traditional analysis, which is based on the hypothesis that emphasis is a consonantal feature, states that emphasis spreads perseveratively from the emphatic consonant to the immediately following /a(:)/. That is, the spreading of emphasis in CA is unidirectional and it is not supposed to occur across the emphatic syllable-boundaries. Further, only /a(:)/

exhibits emphasis categorically while the other vowels and all the plain consonants do not.

This traditional analysis covers four major elements: (i) the source of emphasis, (ii) the direction of emphatic spreading, (iii) the domain of the spreading, and (iv) the target segment which exhibits emphasis. As stated above, emphasis in *tajwid* is a consonantal feature, so the source of emphasis must be a consonant. The other three elements appear to be categorical and, in a sense, they go against a purely phonetic reading of emphasis. That is, if emphasis in this style were dictated by the bio-mechanical demands of the vocal organs rather than by an underlying rule it would not have a constant domain which it cannot override nor a single direction that it cannot reverse. Conversely, if the traditional analysis is accurate then it is possible to assume that emphatic coarticulation in CA is considerably restrained. That is, the phonology is so strict that the various effects which emphatics usually tend to have on neighbouring segments are strictly suppressed. This assumption is consistent with the fourth element above where the target segment that exhibits emphasis is only /a(:)/. But it should also be borne in mind that the exclusion of the other vowels from this approach does not imply that they show no low-level coarticulatory effects from emphatics, as we commented earlier. In fact, the scholars of *tajwid* explicitly state that all the vowels are affected by emphatics.

The *tajwid* scholars thus treat emphasis as a categorical feature whose source, direction and domain of spreading as well as its target segments are all specified in the grammar. These assumptions are consistent with a broadly phonological reading of *tajwid*. One of the aims of the experimental work in this thesis is to lend plausibility to such a phonological interpretation.

3.5 Emphasis in current phonological theory

3.5.1 Distinctive feature analysis of emphasis

There have been several attempts in the last forty years or so to classify emphatics in terms of features, both acoustic and articulatory. For example, Jakobson (1962) adopts the acoustic feature [+flat] which is defined with the lowering of one or more formants on the spectrum (remember that emphatics are characterized by an explicit lowering of the second formant of the adjacent vowel). Articulatorily, the segments specified for this feature are produced by narrowing the back or front orifice of the oral cavity. Labials produce a similar acoustical effect to that of emphatics. At the same time, Jakobson emphasizes that labialization and pharyngealization (emphasis) do not contrast within one language. For example, Jakobson, Fant and Halle (1952) state that "the Bantus and the Uzbeks substitute labialized articulations for the corresponding pharyngealized consonants of Arabic words" (p.31). Also, Jakobson (1962) assumes that emphatics generally tend to reinforce protrusion and slight labial rounding. Therefore, he decides not to limit [+flat] to emphatics but also to include labials. And since pharyngeals are also produced with a constriction in the back orifice of the vocal tract he groups them together with emphatics and labials so that they could constitute a natural class.

Although Jakobson's [+flat] conforms with *tajwid* for the treatment of emphatic coronals and uvulars as a natural class whose members probably function similarly, it contradicts it for the inclusion of the labials and pharyngeals. We have no detailed information about the phonology of the North Palestinian Druzes on the basis of which Jakobson drew his conclusions about labials and pharyngeals, but one could generally get the impression that the principle of distinctiveness was sacrificed for the sake of economy. That is, Jakobson might have thought that for a formal feature analysis of Arabic to be efficient features need to be reduced to the minimum possible limit. Moreover, Jakobson is known for his use of sets of features for both consonants and vowels assuming that all speech sounds are produced by the same vocal tract. His theory identifies as many traditional dimensions as possible with one another and brings them together under one general definition, with the prediction that they cannot function independently. His proposal is to reduce the number of features to a minimal set of articulatory, acoustic and auditory dimensions that would ultimately lead to a richer theory of the phonological systems of the world's languages (Anderson 1985; discussion about Jakobson's feature system).

Although Jakobson's approach is interesting it leaves unresolved problems which it apparently fails to account for or predict. For example, pharyngeal /ʕ/ and /ħ/ are plain in many dialects (including CA). Consequently, they do not spread any emphasis to adjacent segments because they lack this feature. Therefore, it is not appropriate to put them together with emphatics. Conversely, the existence of emphatic pharyngeals (as in some Gulf dialects) may also be problematic. According to Card (1983), since emphasis involves the superimposition of a pharyngeal constriction, which is flatness in Jakobsonian terms, and /ʕ/ is already [+flat], it is not possible to distinguish the emphatic and plain allophones of this particular segment. She argues that [+flat] is not even adequate for the writing up of phonological rules because it does not consider the relationship between the underlying level and the phonetic output. Sounds that are not underlyingly emphatic may exhibit emphasis through featural spreading, but such allophones will still be specified for [-flat] in the feature matrix of Jakobson. In other words, this approach does not well account for the spreading of emphasis from a trigger to a target segments, and it fails to capture allophonic variation of segments on the surface representation.[21]

Card (1983), accordingly, proposes the acoustically-based feature [+F2 drop] for emphatics and differentiates between a second formant which drops (i.e. it is lowered) in emphatic environments and an inherently low second formant which is characteristic to labial /u(:)/ and /w/. This proposal creates other problems. One may wonder why Card substitutes a superficially phonetic term that may not very be accurate for other well-established phonological terms that are adopted in the literature. She states that "an acoustic feature has been chosen merely because the data available are all acoustic" (p.116). But she also argues that "a phonetically-based feature is needed to describe emphasis" (p.114). She criticizes a number of articulatory-based features which have been proposed for emphatics and prefers to avoid [+flat]. She assumes that [+F2 drop] is more appropriate because it merely covers emphatics as a natural class. We have no idea what phonologists would think about her arguments. But from a phonetic perspective, the use of this feature apparently overlooks the role of the first formant in the acoustic cueing of emphasis in spite of its potential relevance as it was argued before. Also, it is rather inaccurate to associate this feature with consonantal segments, particularly those that exhibit no formants on the spectrum, and develop autosegmental representations that would spread [+F2 drop] from trigger consonants to vowels or other segments that

[21] Card does not mention /ħ/ in her discussion. But if it has an emphatic allophone like /ʕ/ the same argument would apply to it.

rather exhibit formants. Therefore, certain articulatory features may be more appropriate than the feature she adopts since trigger segments induce their articulatory effects in target segments and not the other way round. In other words, specifying a trigger segment for a given articulatory feature meets phonetic facts more properly.

Among the articulatorily-based features proposed for emphatics are [+low +back] in the *SPE* featural system. It was stated in Chapter Two that [-high] is not consistent with the articulation of the uvulars because they involve a high tongue body (McCarthy 1994). In *SPE* [low] refers to a depressed tongue position and [back] refers to a retracted tongue body. Both features are used with pharyngeals which, as stated above, differ functionally from emphatics at least for the latter's spreading of emphasis to adjacent segments. Therefore, it might not be appropriate to use these features with emphatics. But it should be noted that the uvulars and pharyngeals may share certain phonological functions. For example, McCarthy (1994) states that the uvular fricatives, pharyngeals and laryngeals behave similarly in respect to co-occurrence restrictions, vowel lowering rules and avoidance of syllable final gutturals. In any case, given the lack of clarity about how emphatics are produced, it seems inappropriate to settle on the *SPE* proposal at this stage.

Other feature proposals have similar drawbacks. For example, [-ATR] (Retracted Tongue Root), which was originally adopted by Stewart (1967) to describe vowel alterations in some West African languages, is used by Hyman (1975), Lindau (1975) and El-Dalee (1984) to describe emphatics, on the basis that the tongue root is pulled backward to narrow the pharynx. But this description would better correspond with pharyngeals than with emphatics (Card 1983). The feature [+CP] (Constricted

Pharynx) is also proposed in the literature. According to Hoberman (1989), it was formerly adopted by Halle and Stevens in an unpublished study and later by Broselow (1976). However, this feature seems largely equivalent to [-ATR]. Moreover, pharyngeals apparently involve a greater degree of constriction in the pharynx than emphatics. It is reported by Laufer and Baer (1988), for example, that the pharynx is highly constricted for pharyngeal articulation whereas it is less constricted and considerably more variable for emphatics. So, the feature [+CP] may also better used with pharyngeals. Finally, Parkhurst (1990) proposes [+PH] (Pharyngealized) and argues that it is more appropriate than [+CP] because the pharynx itself does not constrict but it is actually the tongue which moves backward in the pharyngeal area and causes the constriction. It seems clear that the debate here is largely a question of how accurate feature names are expected to be. But does the phonological theory require the use of very specific phonetic feature names or is it rather more efficient to adopt general feature names that can be readily used in formal representations and the writing up of rules? This is a more general problem with feature theory that it is beyond the scope of this thesis to resolve.

Before concluding this section we should mention the representations of emphatics in work based on the idea of feature geometry (e.g. Clements 1985, McCarthy 1994 and Lee 1994). McCarthy (1994) argues that the classification of Arabic gutturals /χ. ʁ, ħ, ʕ, h, ʔ/ should be based on their place of articulation, rather than on the major articulation. He proposes the feature [pharyngeal] as a primary articulation for these sounds parallel to the three widely-recognized features [labial], [coronal] and [dorsal]. One main difference between [pharyngeal] and the other three features is that the former does not involve a specific articulator. It is mainly defined as "the orosensory pattern of constriction in the broad region of the pharynx which encompasses the larynx through the oropharynx, a constriction locus that correlates acoustically with a relatively high F1" (p.192). McCarthy follows Perkell (1980) who assumes that distinctive features are orosensory targets. He further proposes that the different between [pharyngeal] and other articulator-based features lies in the varying distribution of sensory-feedback mechanism in different regions of the vocal tract. His proposal is that [labial], [coronal] and [dorsal] be grouped together under an oral class node that this node can be dominated by a higher place node along with [pharyngeal]. He claims that [pharyngeal] can, but need not, pattern phonologically with the other three place features. These points are illustrated in Fig.(8) below. Note that the Laryngeal Node is not regarded as a place of articulation possibly because the laryngeals are considered placeless in some phonological studies (e.g. McCarthy 1994 and Lee 1994). The figure expresses the asymmetry between anterior part of the vocal tract, which is organized in terms of active articulator, and the posterior part, which is organized in terms of place of articulation.

The feature [pharyngeal] along with the feature [coronal] characterizes the coronal emphatic consonant and the former feature distinguishes emphatic from plain coronals. The gutturals /χ, ʁ, q / are specified for [dorsal] and [pharyngeal] (note that /q/ differs from the other uvulars because it is a stop). That implies that McCarthy, even though he does not call the uvulars emphatic in his study, assumes that all the sounds traditionally classified as emphatic involve pharyngealization. But, according to his approach, [pharyngeal] is primary for /χ/ and /ʁ/ while it is secondary for /q/ as well as for the emphatic coronals (Jarrah 1993). Whether [pharyngeal] is to be treated as primary or secondary, however, it is clear from his discussion that he considers this feature primarily consonantal and that it underlies the assimilation of /a(:)/ in emphatic contexts.

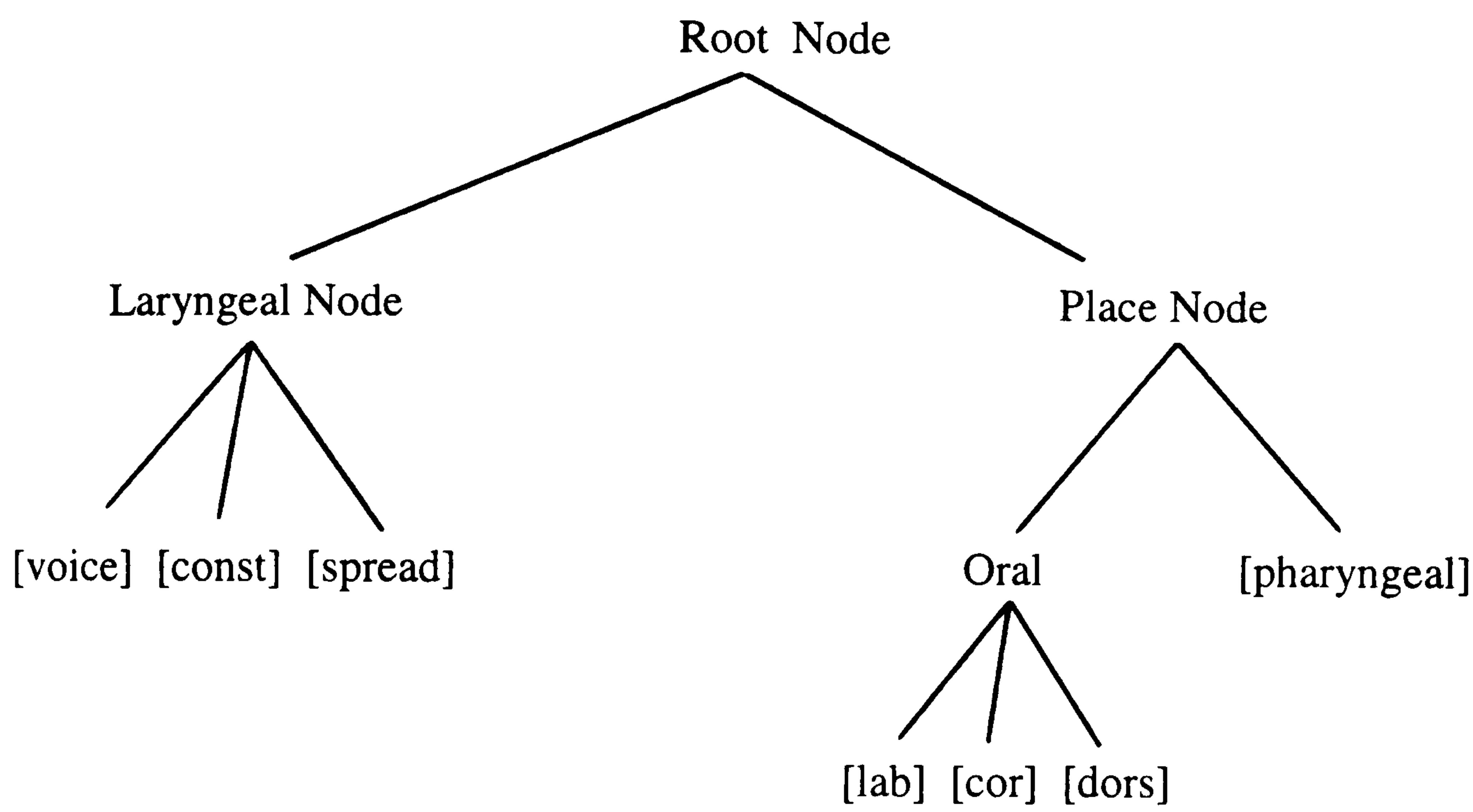

Fig.(8): Feature geometry of emphasis (McCarthy 1994)

An important aspect of McCarthy's analysis to consider is that it groups together the six gutturals under a place feature, which is the pharynx, and does not classify them according to active articulator. Phonetically, that may be justifiable because the articulation of some gutturals is still unclear. This approach also looks similar to the one of *tajwid* since the latter ranks the two uvulars /χ / and /ʁ/ among the pharyngeals.

It was seen in the previous chapter that /χ/ and /ʁ/ are traditionally classified as pharyngeals along with /ʔ, h, ħ, ʕ/. One possible explanation for this slightly confusing taxonomy is that the pharynx in tradition could have covered a larger zone than in the modern sense of the word. Accordingly, laryngeals were also included and not only the two uvulars above. On the other hand, uvular /q/ was excluded possibly because it is not as posterior as /χ/ and /ʁ/ or maybe because its point of articulation and its active articulator are clearer than for the others. These are explicit phonetic explanations for why certain uvulars were traditionally treated as pharyngeals. However, it is also worth noting that McCarthy (1994) reports that the uvular fricatives, pharyngeals and laryngeals behave like a natural class and that /q/ does not pattern consistently with them. For example, roots rarely or never contain two adjacent identical gutturals. Another co-occurrence restriction reported by Lee (1994) is that gutturals cannot occur adjacent to velar and uvular stops. These findings could give rise to controversy about the accuracy of the traditional classification which treats emphatic coronals and /χ, ʁ, q/ as a natural class and eliminates the laryngeals and pharyngeals. Actually, the traditionalists apparently use two criteria for their classification of sounds into emphatic and non-emphatic. The first criterion is purely phonetic because it tackles the way the sounds are produced (the tongue back raising). The second criterion, on the other hand, probably tackles the spreading of emphasis, its domain and its target segments. In CA all the sounds classified as emphatics pattern phonologically as a natural class with respect to the second criterion. It is worth speculating that the *tajwid* classification of the two sounds /χ/ and /ʁ/ as pharyngeal rather than uvular consonants could have been based on criteria other than (or in addition to) articulation. That is, it is quite possible that the six sounds /ʔ, h, ħ, ʕ. χ, ʁ/ were put together under the pharyngeal class because they share a particular phonological or morphological behaviour which is not explicitly mentioned in *tajwid* manuals. Unfortunately, these points are hardly explored in either modern *tajwid* literature or phonological studies of CA.

To conclude, the modern feature analysis of emphatic consonants, from Jakobsonian [+flat] (1962) to the geometrical representations as proposed by McCarthy (1994), is still subject to considerable disagreement. Previously, it was seen that the articulatory properties of emphatics are controversial. It seems that the feature analysis of emphatics has a similar problem. Two problems actually are involved here. First, it is not yet clear how far accurate the feature selected should be regarding the question of phonetic realism. In other words, are distinctive features supposed to be accurate phonetic entities? If so, then it is not possible to select one particular feature and discard some possible others because we are still not quite sure which articulator is crucial for the production of emphatics. The use of acoustic features may be also problematic for similar reasons. The second problem is the phonological behaviour of emphatics which covers different functions such as the extent to which they assimilate other segments and the way they function and cluster in roots/stems to compose utterances. The implication of these points for the general phonological theory is that it is sometimes difficult to select a single phonological criterion on the basis of which features can be associated with emphatics. This is true with the *tajwid* phonology as much as it is true with current theories of distinctive features. However, it is plausible to argue that the adoption of features whether for emphatics or for other consonants should not be merely based on descriptions of their phonetic properties; phonological behaviour should also be considered.

In this study, we are primarily interested in the way the feature spreads regardless of what exactly it might be called. In our present state of knowledge and the current status of the feature theory this issue is not really decidable. We previously decided to adopt 'emphasis' as a uniform phonetic entity which does not denote any particular articulatory activity. For our discussion to be consistent throughout the thesis we will similarly adopt [emph] as a covering term, a distinctive feature under which a group of segments function as a natural class. We will further enclose this conventional feature name between square brackets and treat it as a true phonetic feature.[22]

3.5.2 Spreading of emphasis and its source

3.5.2.1 The source of emphasis

The early *tajwid* scholars and their successors argue that emphasis is a consonantal feature. Some modern phoneticians (e.g. Obrecht 1968 and Card 1983) tend to adopt the same view. For example, Card (1983) argues that emphasis may never proceed beyond its source as in *ṭīn* [ṭi:n] 'mud' in Palestinian Arabic. She states that in this utterance /i:/ resists the spreading of emphasis and, therefore, the phonological categorization of this feature entails that it is consonantal. However, her approach is not probably accurate because a low-level of articulatory effect on the

[22] We actually found that Ali and Daniloff (1972) also use [emphatic] in their study although their investigation is basically physiological. In other words, they did not attempt to adopt a more specific phonetic term that would express their view of emphatic articulation.

vowel must be recognized. Further, the claim that /i:/ resists emphasis is vague. Card does not explicitly distinguish between a physiological and an abstract blocking of emphasis. But she could have argued instead that it is hard to demonstrate that emphasis originates from the vowel because there exists a minimal pair like *ṭīn* [ṭi:n] 'mud' and *tīn* [ti:n] 'figs' in Arabic. In this case it is possible to assume that the vowel spreads emphasis to the consonant in one utterance but not in the other.

Ferguson (1956) and Lehn (1963) attempted to explore this question. Ferguson states that analyzing the vowel as the source of emphasis proved unsatisfactory because instances of emphatic consonants may occur without vowels at all as in *ṣ* 'hush' (interjection) in Syrian Arabic. But he also comments that this instance may not be included in the phonological system on the basis that it is only a vocal gesture. By contrast, he says that in certain dialects the occurrence of emphatic vowels cannot be predicted from the surrounding consonants as in *ktāb* [kta:b] 'write' (North Lebanese Arabic) and *mbārak* [mba:rak] 'blessed' (Cairene Arabic). Ferguson further speculates that in Cairene /a(:)/ could have split into two separate emphatic and plain vowels. He points to the existence of emphatic and plain /m, b, l/ which contrast phonemically only next to /a(:)/. In other words, these three sounds get emphasis from the following vowels. Examples (quoted from Harrell 1957) include (i) [ʔuṃṃa:l] 'of course' vs. [mæl] 'money', (ii) [ʔaḅḷa] 'ma'am' vs. [ʔabla] 'before' and (iii) [waḷḷa] 'by God' vs. [walla] 'or'. However, this approach fails to indicate why the final [ḷ] in the first word in (i) is not emphatic although it is immediately precede by [a:] whereas it is emphatic in the first word in (iii). Also, in [ʔaḅḷa] it is possible that the [ḅ] is emphatic because it is followed by emphatic [ḷ]. Ferguson acknowledges that assuming that emphasis spreads from vowels to consonants could lead to considerable phonological complications. Lehn (1963) further states that it doubles the vowel inventory and creates problems in the morphological analysis of Arabic.

Another possibility is that emphasis is fundamentally tied to both consonants and vowels and not necessarily to a particular class of individual segments. A number of linguists (e.g. Harris 1951, Harrell 1957, Ferguson 1956, Lehn 1963, Obrecht 1968, Ghazeli 1983, Rajouani *et al* 1987 and El-Halees 1985) adopt the view that emphasis is a prosodic or suprasegmental feature (sometimes known as a long component). The basis for their claim is that emphasis is not confined to a single segment but it rather has a domain over which it can extend. Obrecht (1968), for example, reports that the domain of emphasis is the syllable while its minimal domain is the string CV or VC. Ghazeli (1983) similarly argues that emphasis is never a characteristic of a single segment but it rather covers the vowel preceding the emphatic consonant as well as the vowel following it, irrespective of word-boundaries. In other words, an intervocalic emphatic consonant usually affects both contiguous vowels, which implies that emphasis can extend over an entire utterance. This view is the basis of the recent autosegmental representations of emphasis (Parkhurst 1990) which are still dominant in current theory. Emphasis is thus no longer analyzed as a segmental phenomenon, unlike in *tajwid*.

3.5.2.2 Autosegmental analysis of emphasis

(i) Autosegmental phonology

In *SPE* phonological representations are linear, consisting of a sequence of segments. Segments are unordered sets of distinctive binary features that have both articulatory and acoustic correlates. The sequence of segments is associated with a hierarchical structure which is non-phonological (morphological and syntactic). Information on stress and morpheme boundaries are included in the linear sequence for the purpose of dividing up the segmental strings into substrings needed for the application of certain phonological rules (Jarrah 1993). This approach treats speech signals as if they could be sliced into consecutive segments each with its own boundaries that explicitly show when it begins and when it ends. In spite of the inaccuracy and limitation of this linear approach which does not correspond with the phonetic reality of speech it was adopted by many phonologists for several decades.

In the early 1970's phonologists such as Leben (1971), Goldsmith (1976) and Clements (1976) started to think that certain linguistic phenomena are best handled in terms of phonological representations that are fundamentally non-linear. The new approach, conventionally known as autosegmental phonology, was originally developed within the generative framework for the analysis of tonal systems that exist in some languages such as Mandarin Chinese (Wang 1967 and Woo 1969) and some African languages (Leben 1971). One main argument raised by Leben was that a single tonal specification may take more than a single segment as its domain, possibly spreading over several syllables in an utterance. Goldsmith arrived at the conclusion that the number of tonal specifications in a given form is not necessarily equal to the number of vowels. In other words, tones should not be attached to particular vowels or syllables because tonal melodies can shift from their positions to others with inflectional or derivational changes. Goldsmith hypothesized that tonal melodies could have their own abstract identity separate from consonants and vowels in a given utterance. Nasality, for example, was considered a good example of the behaviour of tones. Clements further argued that autosegmental analysis could be useful not only for the study of tone but also for vowel harmony. He accordingly recommended that the domain of the autosegmental theory be extended to account for non-tonal phenomena. So, he analyzed vowel harmony in some languages such as Hungarian (1976) and Akan (1981) within the autosegmental framework.

(ii) Autosegmental approaches to emphasis

The behaviour of emphasis in Arabic resembles the behaviour of tonal melodies, nasalization and vowel harmony in some other languages. In many Arabic dialects emphasis often spreads over several syllables and it may even affect an entire utterance and cross word boundaries. Accordingly, it is quite possible to set up a separate autosegmental tier for emphasis, whatever the feature name might be, and determine its phonological behaviour accordingly using the conventional autosegmental association lines for the purpose of providing an adequate analysis of the spreading and blocking of emphasis. Among the studies that have tackled emphasis within the autosegmental framework are Card (1983), Parkhurst (1990), Hoberman (1989), Davis (1993) and Younes (1993).

The chief phonological problem in the description of emphasis is to predict the extent of the span through which emphasis spreads (Hoberman 1989). The problem is the great variability which emphatics show among different dialects. One possible reason for this variability, which may pass unnoticed by some phonologists, is that emphatics are not articulated the same way by Arabic speakers who come from different educational backgrounds, sex group and age. This problem could significantly affect both the extent to which emphasis can spread over adjacent syllables and the way emphasis is analyzed in the phonology.

Card (1983) analyzed emphasis in Palestinian Arabic using speakers from rural and urban areas (she claims that there was no apparent difference in the spread of emphasis between the two groups of speakers). Her study was based on acoustic measurements. It was stated above that she adopted the feature [+F2 drop] in her analysis. She distinguishes between underlying or primary emphatics, which are /ṭ, ḍ, ṣ, ẓ, ḷ, ṃ, ḅ/ in the variety she examined, and secondary (merely phonetic) emphatics assuming that the former spread emphasis to the latter. Her main observation is that an emphatic span may be as short as a single segment or as long as a whole polysyllabic utterance as in *ṭīn* 'mud' and *bkhāṭrak* 'goodbye', repectively. Contrary to some prosodic analyses, however, she argues that emphasis cannot be merely a prosody which is to be associated with a stretch of segments. She argues that emphasis emanates from the consonant and hypothesizes that the spreading of emphasis is blocked by /i:,ʃ, j/ for purely physiological and acoustic reasons. The segments that block emphasis are underlyingly associated with the feature [-F2 drop], and these block the spreading of association with an underlying emphatic consonant. Card assumes that /u:/ and /w/ are transparent to association with [+F2 drop], i.e. they are not affected by this feature, but they do not themselves block its spreading.

Consider Card's representations in Fig. (9) below. Three tiers are shown: (i) [F2 drop] tier, (ii) the segmental tier and (iii) the CV-tier. The last tier is adopted from McCarthy (1981) for the structure of syllable. Geminate segments and long vowels are represented by a single element on the segmental tier which is mapped onto two consonants or two vowels on the CV-tier. We can see that, in accordance with Universal Well-Formdness Conditions (Goldsmith 1976), the representations below show that the association lines do not cross. The solid lines connect the trigger segments with [+F2 drop] on the higher feature tier. The association lines which are the result of mapping are dashed. The spreading of [+F2 drop] carries over until it encounters the blocking feature [-F2 drop] which does not itself spread to any segments. Note that Card uses under-dotted vowel symbols to indicate emphasis on the vowels and duplicated vowel symbols to express long duration of vowels.

(a)

[F2 drop]	[+F2 drop]	[-F2 drop]	
Segmental tier	ṭ	i	n
CV-tier	C	V V	C

Phonetic output [ṭi:n]

(b)

[F2 drop]	[+F2 drop]		[-F2 drop]		
Segmental tier	ṭ	a	j	a	r
CV-tier	C	V	C C	V V	C

Phonetic output [ṭạjjær]

(c)

[F2 drop]	[-F2 drop]		[+F2 drop]
Segmental tier	sh	a	ṭ
CV-tier	C	V	C C

Phonetic output [ʃạṭṭ]

(d)

[F2 drop]			[+F2 drop]	[-F2 drop]
Segmental tier	f	a	ḍ	i
CV-tier	C	V V	C	C

Phonetic output [f̣ạạḍi]

(e)

[F2 drop]	[+F2 drop]
Segmental tier	ṭ u b
CV-tier	C V V C
Phonetic output	[ṭu:ḅ]

Fig.(9) : Mapping of the feature [+F2 drop] onto unassociated segments (Card 1983)

It appears that Card is very much motivated by the notion of the physiological/acoustic blocking of emphasis. She further agrees with Ghazeli (1977) that vowels like /i/ and /i:/ resist emphasis because their articulation involves a tongue movement which is antagonistic to the one require for the production of emphatics. Other phonologists (e.g. Hoberman 1989 and Davis 1993) adopt a similar view. But it should be noted that the employment of such a view within a theoretical framework is a bit confusing. More specifically, it is not yet clear how we can reconcile a physiological blocking with an abstract spreading of emphasis. In the standard autosegmental theory, both the spreading and blocking of features (including emphasis) belong to the abstract level of language. In other words, it is not expected that one of the two processes (or both of them) will be treated as a mechanical output of the underlying level. Accordingly, Card and other's similar approaches fail to capture the theoretical essence of spreading and blocking by mixing the phonology with the phonetics. In fact, Card's approach is not accurate even from the phonetic standpoint as it was argued before. Her representations indicate that the feature [+F2 drop] is consonantal and that it spreads to the vowel. Basically, that could be acceptable because phonologically emphasis spreads from the consonant to the vowel and the effect is realized phonetically by getting the second formant of the vowel lowered. However, attributing this feature to consonants could also be misleading particularly because some emphatic consonants have no formants on the spectrum.

Davis (1993) reports that dialects vary greatly as to the extent to which neighbouring sounds become emphatic. He agrees with Younes (1993) that in Cairene Arabic, for example, if there is one emphatic consonant in an utterance then the entire utterance becomes completely emphatic. By contrast, he states that in some other dialects (he does not specify any) only an adjacent low vowel (/a(:)/) becomes emphatic. His claim is that emphatic spread in rural Palestinian Arabic falls between the two extremes. Although this claim could imply that utterances in rural Palestinian Arabic can only be partly emphatic with at least two syllables exhibiting emphasis, the examples illustrated by Davis contradict this assumption. In several cases words are entirely emphatic. What is interesting in Davis' analysis, however, is the argument that the segments that block perseverative emphatic spread (which are /i(:), j, ʃ, dʒ/ in his study) fail to block anticipatory spreading of emphasis. Thus, while Card (1983) assumes that emphasis blockers are the same regardless of the direction of the spreading, Davis appears to be establishing a phonological rule which determines whether emphasis is to be blocked or not depending on its direction. In fact, he explicitly comments that the segments that block the spreading of emphasis in one dialect may not be opaque to this process in some other dialects. This approach to the problem of emphatic blocking is superior to Card's, because Davis is explicitly eliminating the interpretation of featural blocking as a physiological process and places it under the phonology. By doing so he is maintaining the theoretical coherence of spreading and blocking as abstract ideas that cannot be attributed to different levels of representations, one abstract and one physical.

Although Davis has a different conception of emphasis (especially its blocking) from that of Card, neither of them explores the relationship between the assumption that emphasis could be a unary feature (see Card's comments above) and the problem of emphasis blocking. Card says that there exists no true contrasting feature to block emphasis. She might have adopted the notion of mechanical blocking of emphasis for that reason. By contrast, Davis reports that emphasis blockers have a phonological function and, therefore, the blocking of emphasis is no more mechanical from his point of view. However, they both fail to discuss the implications of the absence of binarism for autosegmental theory in its current framework. If it is true that emphasis is a unary feature then the autosegmental approach will need to account for this problem so as to make the grammar more predictive as regards the behaviour of emphasis in Arabic. At present, the autosegmental studies that have so far tackled the spreading and blocking of emphasis are less appropriate than might be expected.

3.6 Comments on *tajwid* and modern phonological approaches

There exist significant differences between the formal analysis of emphasis in *tajwid* and current phonological theory. One main difference lies in the adoption of a linear approach in tradition as opposed to a non-linear approach (basically autosegmental) in current theory. Emphasis is traditionally regarded as a consonantal feature which spreads categorically from the consonant to the vowel in a perseverative direction. This approach is based on the way the early scholars conceived the syllable as the structural domain of emphatic spread in CA. By contrast, current approaches offer a non-linear treatment of emphasis. The autosegmental approach is presently the dominant trend. A number of phonologists such as Card (1983), Hoberman (1989) and Davis (1993) have analyzed emphasis autosegmentally. Their contributions, though deficient in some respects especially in the analysis of emphasis blocking, are still important. Particularly with a phenomenon like emphasis where dialects exhibit a great range of variation and complexity it appears that the autosegmental theory is still promising. But there remains a lot of work to be completed before thorough analysis of emphasis can be achieved.

Problems have arisen in part because some phonologists (e.g. Card 1983) have attempted to explain the blocking of emphasis in purely phonetic terms. We tend to agree with Pierrehumbert and Beckman (1988), Keating (1990) and Cohn (1993) that certain phonetic data should be attributed to the grammar because they show systematic differences among languages. But the studies reviewed in this chapter could not capture this hypothesis and investigate it thoroughly.[23] In other words, there exists a gap between the autosegmental treatment of emphasis, on the one hand, and the theories of the phonology-phonetics interface, on the other. Analyzing emphasis autosegmentally is not all that we need today. The relationship between phonology and phonetics has not yet been explored in the autosegmental studies of emphasis in

[23] Davis (1993) hints at the existence of language-specific phonetic rules when he refers to emphasis blockers, but he gives no further details.

Arabic. Therefore, it might be appropriate to investigate emphasis within a broader theoretical framework in the light of current theories of the phonology-phonetics interface.

3.7 Summary

The principal objective of this chapter has been to discuss and evaluate various traditional and modern phonetic and phonological studies of emphasis in a number of Arabic styles. It was indicated that *tajwid* is not engaged in the kind of dispute and complexity which modern phonetics and phonology are engaged in. From the phonetic standpoint, the *tajwid* scholars came to agree that emphatic articulation involves the tongue back raising. Yet, we speculated that some traditional descriptions may also be taken to mean that other articulatory activities were observed by some scholars. Modern phoneticians appear to have investigated emphasis thoroughly in various colloquials using modern tools, and their contributions are undeniable. They have shed light on the complex nature of the emphatic gesture and shown that the production of emphatics does not merely involve the tongue back raising as it is traditionally assumed. But some articulatory descriptions are so specific that they may not be needed for a broad phonological description. In any case, we have decided to treat emphasis as if it were a uniform phonetic entity and give it the label 'emphasis' accordingly.

One main difference between the articulatory and acoustic studies of emphasis is that the latter show far more agreement. The articulatory properties of emphasis are still unclear. This could be due to the difficulty of exploring remote areas in the pharynx and/or to other physiological factors and technical problems. But the acoustic analysis also has its own problems and limitations. One problem is that the raising of F1 frequency value of the vowel (particularly /a(:)/) is less clear than the lowering of its F2 frequency value. The lack of consistency in the F1 data could have led some phoneticians and phonologists to minimize the role F1 plays in the acoustic cueing of emphasis. It is important to emphasize that our decision to focus on F2 measurements in the experimental study does not imply that F1 is a non-significant parameter.

The acoustic analysis of emphasis may provide an objective approach to the problem of emphatic coarticulation. Previous studies have demonstrated that emphatics commonly affect adjacent segments. The effect can extend over several syllables and may even cross word-boundaries. The coarticulatory effects are clearer on vowels than on consonants in acoustic data. The major problem with emphatic coarticulation lies in the question whether it is to be regarded as a low-level phenomenon or as a grmmatical behaviour. Phoneticians and phonologists appear to disagree about this particular issue. We argued that whereas certain data could give support to a phonetic reading of emphatic assimilation, other data explicitly go against the phonetics in favour of a phonological reading of emphatic assimilation. However, it is not possible to make a final judgement about this problem particularly in the light of the relatively limited number of studies that have so far tackled emphasis autosegmentally. In other words, there is still work to be done before it can be decided whether emphatic assimilation belongs to the phonetics or to the phonology.

In the next chapter we will report and discuss the results of the acoustic analysis of the data recorded in the present study. The empirical investigation will hopefully be highlighted by some previous findings about emphasis, especially by information about the transitions of the second formant of the vowel in emphatic environments. We begin by accepting the traditional claims about the domain and direction of emphatic spread in CA, but we also assume it is worthwhile examining the validity and accuracy of those claims using a more solid criterion than mere impressionistic judgements about the systematic behaviour of emphasis in recitation style.

CHAPTER FOUR
THE EXPERIMENTAL STUDY

4.0 Introduction

This chapter discusses the details of the acoustic study. We indicated in the last chapter that one of the questions about *tajwid* is whether emphatic assimilation is a low-level phonetic process of emphatic coarticulation or an underlying process that can be attributed to the linguistic grammar. The main argument was that ascribing emphatic assimilation to the phonetics or to the phonology is subject to further research and debate. We also saw that it is plausible to claim that the acoustic analysis of emphasis, particularly the measurement of the second formant frequency of the vowel in emphatic environments, can provide us with a straightforward and objective technique for the study of emphatic assimilation in Classical Arabic. Therefore, the principal goal of the study reported in this chapter is to make a number of acoustic measurements of F2 values in utterances taken from CA and MSA and compare the different categories of speakers and styles we are interested in. The empirical investigation will not only lead to the assessment of the *tajwid* claims about the phonetic correlates of vowels before and after emphatic consonants, but it will also allow us to address the issue of the phonology-phonetics interface in relation to the acoustic parameters of Qur'anic recitation. It should be noted that the ultimate goal of the acoustic comparison in this entire study is not merely to decide whether the speakers/styles examined are similar or different. Basically, we are attempting to make objective judgements about the place of emphatic assimilation in the linguistic grammar of CA. Such an ultimate goal may go far beyond comparing speakers or styles so that one can reach a greater understanding of emphatic assimilation in the light of current linguistic theory.

4.1 Method

4.1.1 Speech materials

4.1.1.1 General description

The MSA recording data was composed of single words, phrases and sentences while the CA data was composed of verses cited in phrases and complex sentences. It was not appropriate to use single words or word-lists from the *Qur'an* in the recordings for the following reasons:

(i) If CA utterances were taken out of their normal context in order to be presented in a list of words and the subjects were further handed a list of ordinary words that were going to be similar or identical with those of CA they were expected to get confused. The reason is the similarity between the scripts used by both styles. Therefore, one way to help our speakers identify each style properly without encountering difficulty and confusion was to present the utterances in their original context.

(ii) Chanting, which often accompanies recitation, is normally carried out with complete verses rather than with single words selected from the *Qur'an*.

(iii) The religious respect for the *Qur'an* imposed the use of complete verses in the recordings.

The data prepared for the recording was presented on 64 cards of medium size along with 8 large sheets. In order to help speakers avoid pronunciation errors that would later affect our analysis and lead to the exclusion of data that might be important it was preferred to add diacritics to the MSA data. CA verses already had their own diacritics.

The total number of test tokens was 340 from CA and 219 from MSA. The number of CA tokens exceeded that of MSA because they were presented in verses. The use of verses gave us the opportunity of collecting more utterances. It was assumed that each speaker should not take more than 30-40 minutes to record all the data, taking into consideration that recitation might require longer time than expected.

The following examples illustrate that although different phrases/sentences were used in the recordings the test tokens (in **bold**) were either identical or very similar in both styles.

	CA	MSA
(i)	**'aḍā'at** ma-hawlaha	**'aḍā'at**-il-masabih
	'it lighted all around him'	'the lamps lighted'
(ii)	kamā **ṣabara**	**ṣabara** kathīrā
	'as (they) patiently preserved'	'(he) patiently preserved greatly'
(iii)	**faqāla** 'ana	**faqāla** li
	'then he said I am'	'then he said to me'
(iv)	**fanṭalaqā**	**'inṭalaqā**
	'then they both proceeded'	'they both proceeded'

(v)	**yunfakhu** fiṣṣsuri	**yunfakhu**-ṭṭawdu
	'the trumpet shall be sounded'	'the mountain has been blown'
(vi)	man **ṭaghā**	liman **ṭaghā**
	'who exceeded bounds'	'for the one who exceeded bounds'
(vii)	**muṭahharah**	**muṭahharah**
	'pure' (feminine)	'pure' (feminine)

4.1.1.2 Styles and models selected

It was indicated in Chapter One that the *Qur'an* is recited according to ten pronunciation models conventionally knowns as The Ten Recitations. Those models are approved by recitation scholars and taught by *tajwid* instructors. It was decided to study the acoustic correlates of emphatic spreading/blocking in the Ḥafṣ-^{c}Aṣim Recitation Model for the following reasons:

(i) This model is probably more widely used than the other models, and it is one of the main recitation models taught at schools, institutes and mosques. It is taught from the very early days of formal teaching. In fact, children are exposed to it before they go to school. The majority of native speakers of Arabic do not know the other recitations (Abu-Al-Khayr 1989).

(ii) It was unlikely to find non-expert reciters who learnt recitations other than the one of Ḥafṣ-^{c}Aṣim particularly at the area where the recording were made (Jeddah, Saudi Arabia).

(iii) MSA has a single pronunciation model which is almost the same in the Arabic speaking countries in spite of some minor differences that may arise (Al-Ani 1970). Impressionistically, the Ḥafṣ-^{c}Aṣim Recitation is more similar to the MSA model than some other recitation models. The goal was to compare two very similar styles.

4.1.1.3 Segments and patterns covered

The recording data covered the seven emphatics /ṭ, ṣ, ḍ, ðˌ, q, χ, ʁ/ and most of the plain segments. The first four coronals contracts phonemically with the plain coronals /s, d, t, ð/. The three gutturals /q, χ, ʁ/ do not apparently have generally agreed counterparts. However, some phoneticians (e.g. Al-Khuli 1987) argue that these are /ħ, ʕ, k/.

It was also decided to include the emphatic allophone of /r/ ([ṛ]) which probably has more frequency in CA than its plain counterpart. Emphatic [ḷ] was not included in the study because it is not phonologically conditioned. In CA it only occurs in the word for God (*Allah*) on the condition that it is preceded by /a/, while it is pronounced plain in elsewhere even when it is preceded by /a/ as in *al-layla* 'night' (see the previous chapter for the status of /l/ in CA).

The data contained all the six vowels of CA/MSA: /i, a, u, i:, a:, u:/. It was important at the early stages of the study to cover all vowels because it was not clear which of them was going to be of interest to our investigation.

Four sets of test tokens were selected from the recording data for the acoustic analysis. Each set contained 8 CA and MSA pairs of identical or similar utterances with the target CVC string being the same in each pair. The consonants were both plain and emphatic, following one of the patterns EP, PE, EE and PP where E represents an emphatic consonant and P a plain consonant. The intervening vowel was /a/. The total number of the tokens was 64. A list of the test tokens is shown in Appendix I.

The EP and PE patterns contained all the segments identified as 'emphatics'. Each CA utterance (and consequently its MSA counterpart) contained one coronal or guttural emphatic which did not occur in the other utterances within the same set. In other words, each emphatic consonant only occurred twice for each style. The utterances were selected on the basis that they contained emphatics. The P segments were thus randomly selected because they happened to be in those utterances. The plain segments in the EP/PE patterns were /n, h, b, ð, d, w, ʕ, ʔ, f/ (note that /ʕ/ is not considered emphatic).

The EE pattern contained 5 emphatics: coronal /ṭ, ṣ, ṛ/ and guttural /ʁ, q/. Some of these emphatics occurred in more than one test token. The data did not contain the remaining emphatics because they had fewer occurrences than others in the recording data. On the other hand, the PP pattern covered 11 plain consonants including the plain counterparts to emphatic coronals in addition to two plain gutturals: /ʔ, b, d, ð, t, s, j , w, k, ʕ, ħ/.

4.1.1.4 Why study /a/?

The data was so extensive that it was necessary to limit the analysis to one vowel. We have selected short /a/ for a number of reasons. The vowels /i(:)/ and /u(:)/ were excluded because they are not affected by emphasis the same way as /a(:)/ as a number of studies indicated (e.g. Card 1982, Al-Ani and El-Dalee 1984, El-Dalee 1984 and Herzallah 1990). This agrees with the *tajwid* view that /a(:)/ exhibits more emphasis than other vowels, as we saw before. We selected short /a/ rather than long /a:/ mainly because it had many more occurrences in the recording data than its long counterpart.

4.1.2 Speakers

4.1.2.3 Expertise

Six experts (referred to here as El-E6) and nine non-experts (N1-N9) were recorded. The ages of the speakers ranged between 24 and 39 years. They were educated and most of them held university degrees.

The expert reciters were already engaged in activities related to recitation such as linguistic research, making recordings, teaching *tajwid*, awarding recitation certificates, reviewing leading works, giving formal speeches as well as leading prayers. All the experts recorded held recitation certificates; and this was the basic criterion for placing a speaker in the category 'expert reciter'. E3 and E4 were experts in The Ten Recitations, thus including Ḥafṣ-ᶜAṣim model which all the experts have learnt. Although the other experts did not learn all recitation models this did not necessarily mean that the recitation of E3 and E4 were going to be superior.

The non-expert reciters held no recitation certificates, and were not engaged in recitation activities in the same way as the expert reciters. But all of them learnt Hafs-ˁAsim recitation model and some of them had background in *tajwid* and experience of teaching it. This suggested that there would be clear differences in the reading abilities among the non-experts. In addition, N9 was a special case among all the speakers because he was preparing to become an expert reciter, but he had not yet met the requirements.

4.1.2.2 Sex

The recordings did not cover female speakers for social and technical considerations. Socially, it was unlikely to find female expert reciters where the recording were taking place, and to get them to agree to be recorded at a studio. Technically, females' F2 frequency is usually higher than that of males (Kahn 1975). Therefore, it was more appropriate to record speakers of the same sex so as to get more comparable data.

4.1.2.3 Dialects

The speakers recorded did not all speak the same dialect. The experts spoke Hejazi Arabic (E1, E2 and E3), Syrian Arabic (E4) and Egyptian Arabic (E5 and E6).

It was not possible to find six experts who spoke the same dialect because the number of expert reciters is generally smaller than that of the non-expert reciters especially if we need experts who have mastery of several recitation models. There was no problem with finding non-experts who all spoke the same dialect (Hejazi Arabic). Thus, it was possible to eliminate any uncontrolled source of variation by the non-experts to a single dialect.

4.1.3 Recording procedure

The speakers were recorded at the same studio by the same technician in order to get recordings of the same quality. They were shown the recording data before being recorded in order to make them familiar with it, but none of them was told the objectives of the study before the recordings were completed as to get as much natural recitations as possible. The speakers were also advised not to worry about mistakes or difficulties they might encounter in order to help them keep self-confidence. They were given short breaks in between the recording sessions and were not interrupted during the recordings. Fortunately, the mistakes they committed were limited and the recordings ran smoothly.

There was no overlapping between the CA and MSA recording sessions. Each session was assigned a separate set of data. Because it was planned to conduct three sessions due to the large data we got we preferred that the first and final sessions devoted to CA and the mid-session only to MSA. We expected that this procedure would help the speakers avoid confusion and interaction between styles.

The selection of the speech rate of the recitation was left to the speakers themselves. They were, however, told that a medium rate was preferable (this was done particularly with the experts). The speakers read the same material, exactly in the same sequence in order to achieve consistency. Each speaker took approximately 35-45 minutes to complete all the recordings.

4.1.4 Apparatus

When the recording were completed the entire acoustic analysis was carried out on a SUNOS4.03 Sparc Workstation at the Department of Linguistics, the University of Edinburgh. The software used was WAVES+ Version 2.0, the interactive graphics interface of the Entropic Signal Processing System (ESPS) Version 4.1. These packages create, manipulate and analyze digital signals and have a variety of capabilities and tools including modification and displaying of sampled data signals (waveforms), wideband and narrowband spectrograms, and other ESPS data files. The Workstation was further connected to a Proport™ Model 656-Ariel, a Sony Digital Audio Tape Deck DTC 690 and a Technics VC-4 Amplifier System/Class AA VC-4.

4.1.5 Acoustic measurements

The measurements taken were the F2 frequency values at three vowel positions in the test tokens: the onset following the first consonant in CVC string, the midpoint of the vowel, and the offset before the second consonant. The onset measurements were taken 20 ms. after the beginning of the vowel and the offset measurements 20 ms. before the end of the vowel. The formant tracking was done on the spectrograms of 48 utterances spoken by each speaker. The formant values were calculated by the computer packages.

4.1.6 Difficulties

The first problem is that there is no straightforward method for normalizing the measurements of the vowel. Formant values are not totally indicative of linguistic correlates of sounds and may be affected by the shape of the vocal tract of the speaker. As Ladefoged (1982) states, "In general, when two different speakers pronounce sets of vowels with the same vowel quality, the relative positions of these vowels on a formant chart will be the same, but the absolute values of the formant frequencies will differ from speaker to speaker. Unfortunately, no one has yet determined exactly how to average out the individual characteristics so that a formant plot will show only the phonetic qualities of the vowels" (p. 194).

Segmenting the utterances (i.e. deciding where the segments began and where they ended by segmenting the spectrograms) was sometimes difficult. In our data, we had to decide where segment boundaries were exactly located. Segmenting the data on the signal windows and spectrograms went smoothly, especially with the coronal stops and fricatives where it was quite possible to see the bursts or frictions of these sounds on the spectrograms and mark the boundaries of the vowel that occurred in their vicinity. For example, in Figures (10) and (11) is it is quite possible to point to both the onset and offset the first and second vowels in the utterance *# ttakhadha*, 'he followed/took' as produced by an expert and non-expert reciter, respectively. In the first and second syllables the onset can be seen immediately after the burst or friction of the consonant and the offset can be seen on the boundary/space that separates between the vowel and the following consonant.

By contrast, segmenting some other utterances was difficult especially those containing laterals and approximants. For example, the string [-jəd-] in Figures (12) & (13), [-ərə-] in Figures (14) & (15) and [-əʕə] in Figures (16) & (17) (the last two refer to an expert) were difficult to measure whether the speaker was an expert or ordinary speaker.[24] It was not always possible to trace the onset and offset values of the intervening vowels because laterals and approximants have formant structures that look like those of vowels (the last two spectrograms are for an expert).[25] A practical solution was to keep segmenting around the points where the sounds were suspected to begin and end, and to repeat listening to portions of the sampled data until the appropriate measurement values were captured.

Finally, a few spectrograms were not clear and the formant tracking (specifically the displaying of frequency frames) was sometimes unhelpful. The quality of such spectrograms might have been affected by factors that we could not control such as the voice quality of some speakers. The formants of some spectrograms were unclear or undulating. Technical reasons might also be relevant to the bad quality of some spectrograms. For instance, some spectrograms had better quality when they were re-sampled. Other spectrograms had their F1 and F2 merging

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[24] We prefer the use of the schwa rather than [a] to avoid confusion between plainness and emphasis. However, it should be noted that we did not examine the phonetic detail of the vowels so as to decide how they were exactly articulated in emphatic and plain environments by our speakers.

[25] See Ladefoged (1982) and Kenstowicz (1994) for the acoustic correlates of laterals and approximants. In the case of /ʕ/ (approximant) Parkhurst (1990: 102) reports that it is actually embedded in a vowel and the duration of that vowel is extended as much as two or three times as that of other vowels. This claim, however, is subject to further investigation since /ʕ/ is a consonantal segment from the articulatory standpoint and the assumption that it is embedded in a vowel is confusing.

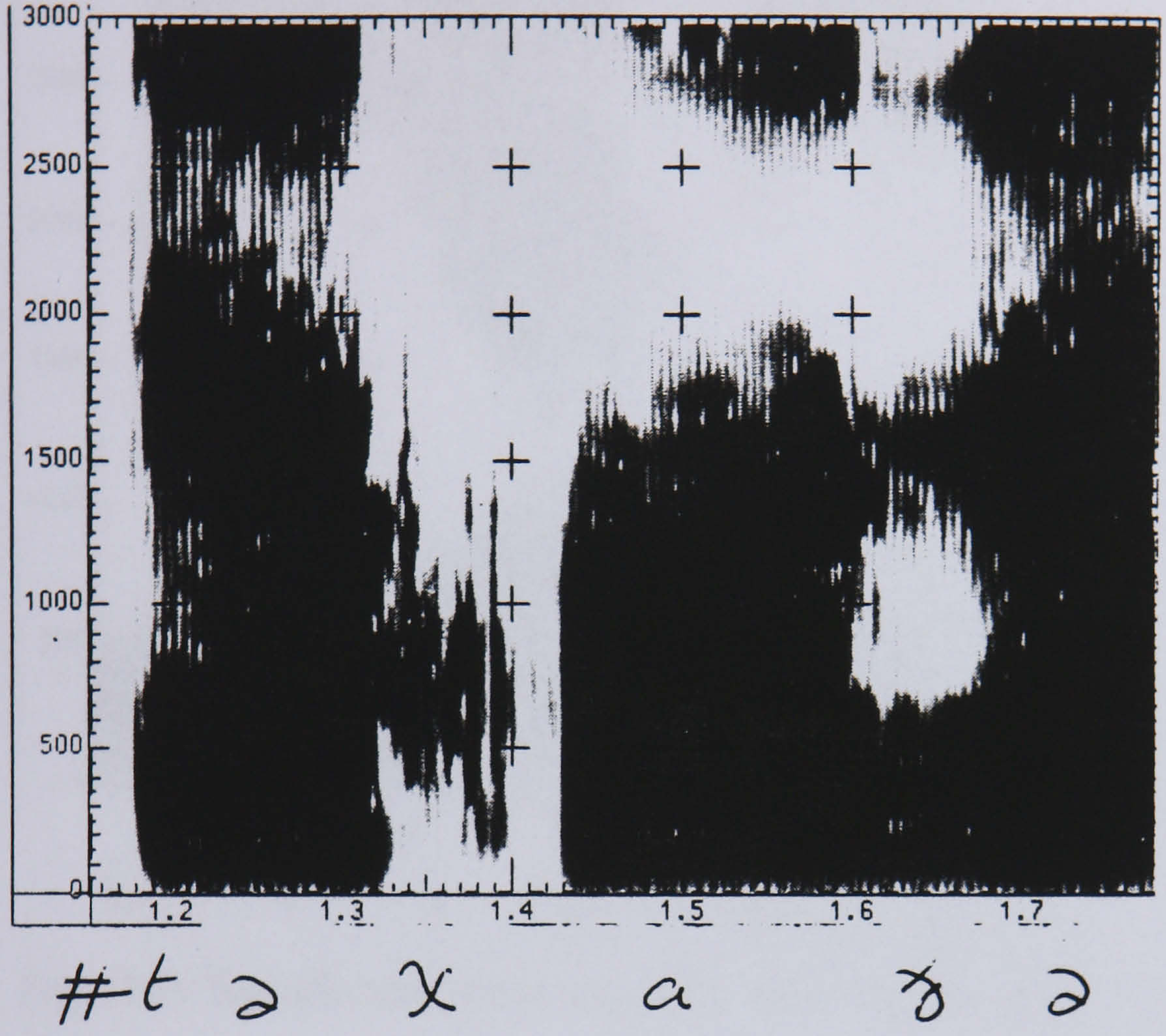


Fig. (10): Sample spectrogram of an expert (difficulties/CA)

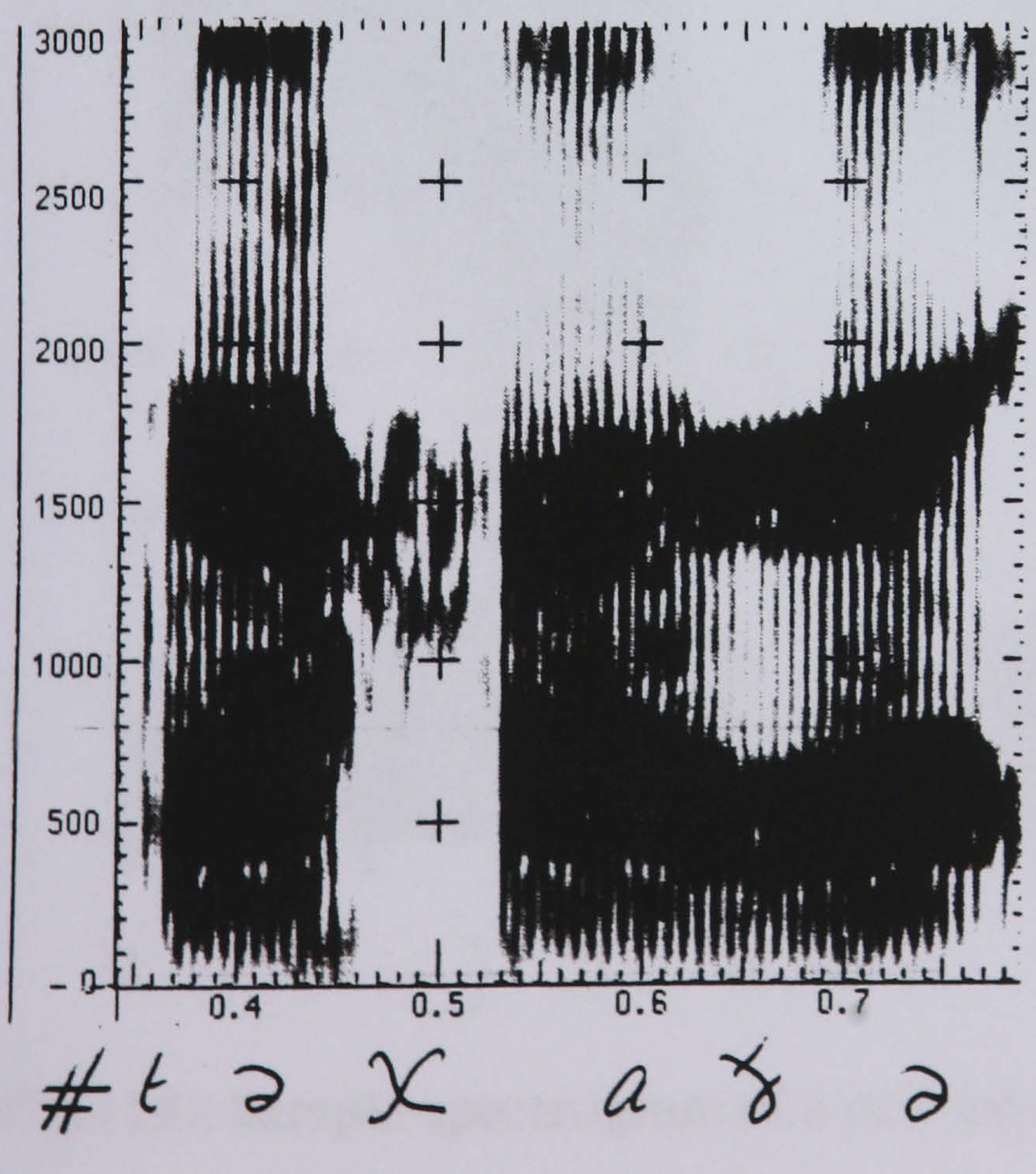


Fig. (11): Sample spectrogram of a non-expert (difficulties/CA)

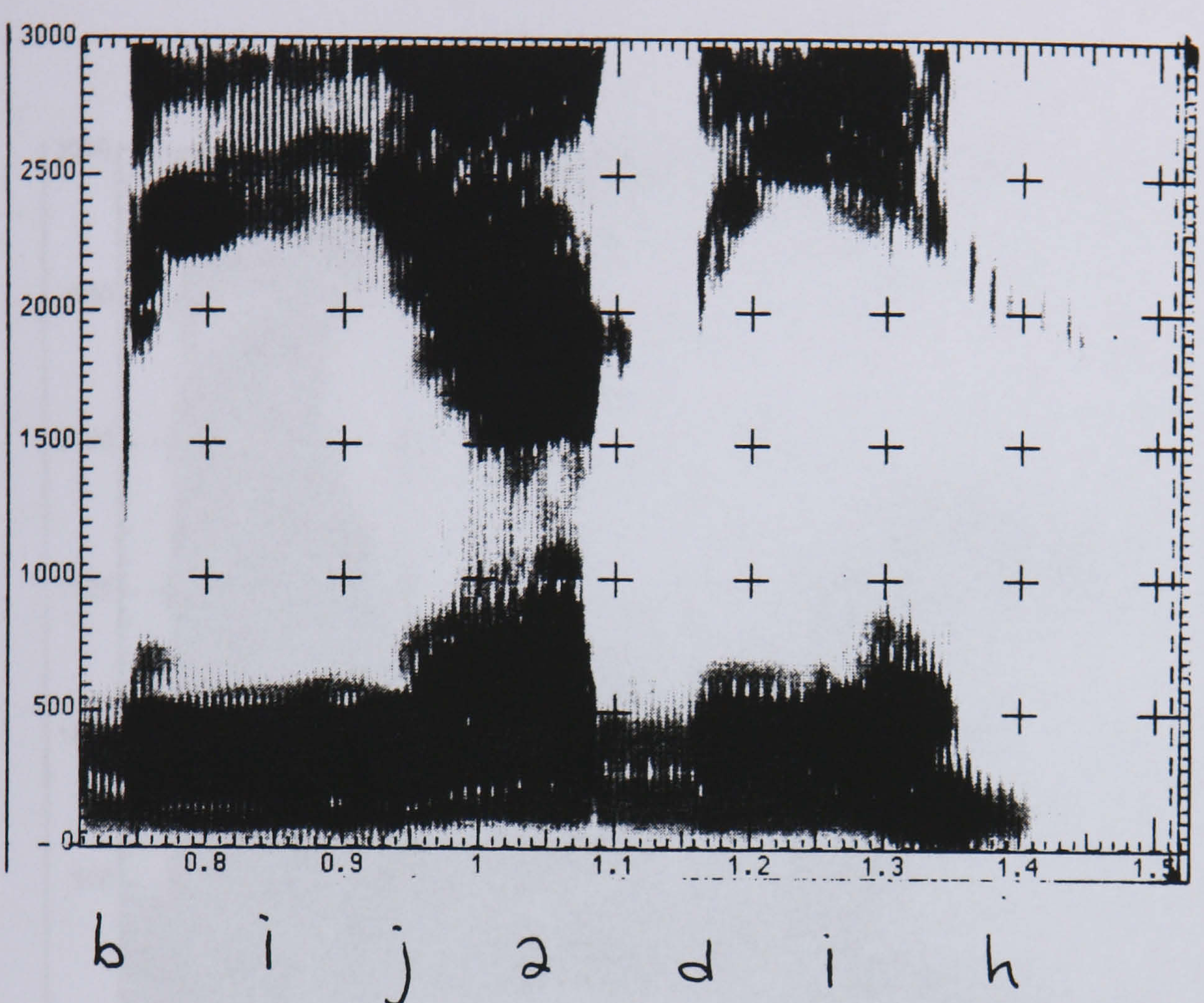


Fig. (12): Sample spectrogram of an expert (difficulties/CA)

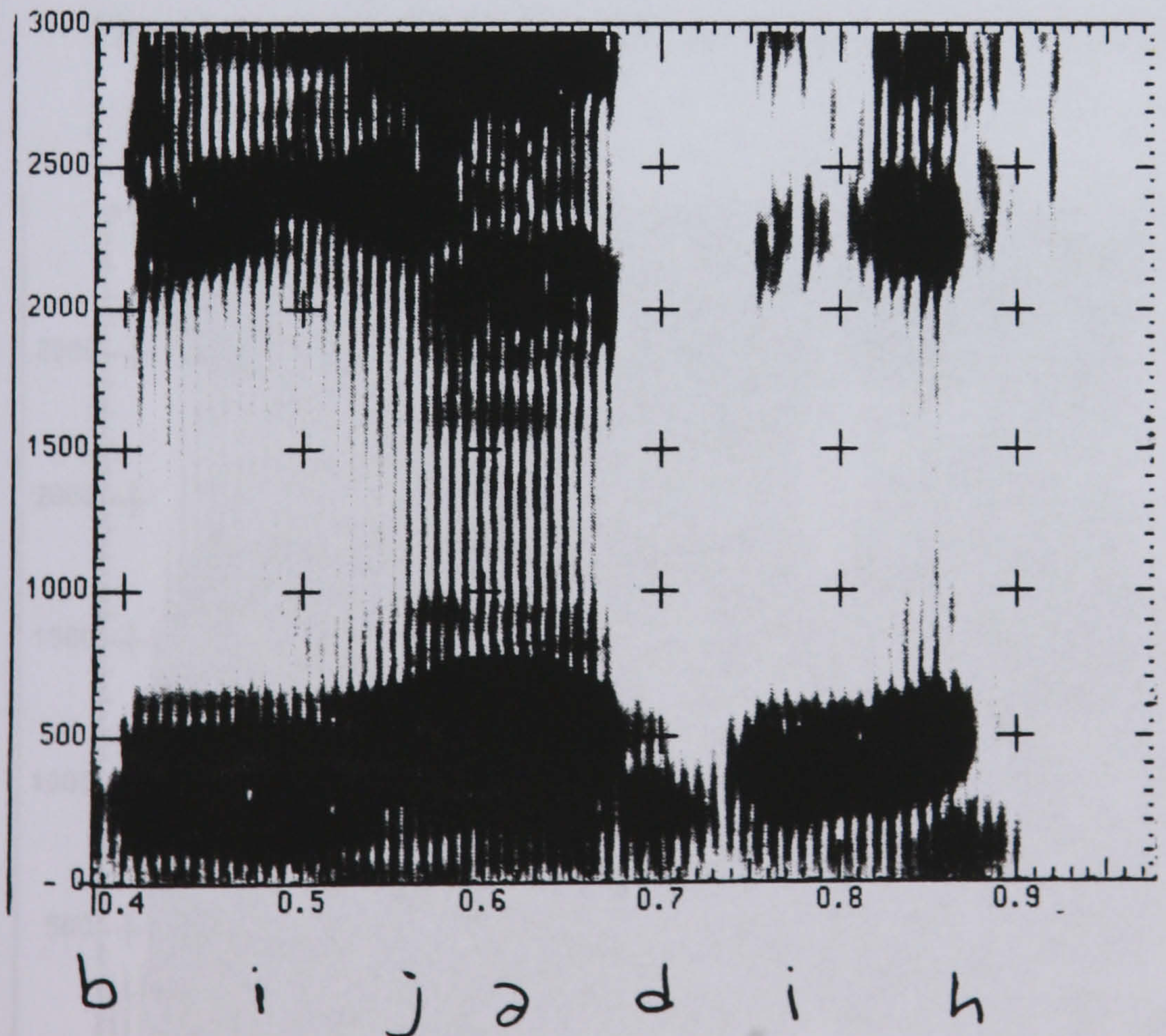


Fig. (13): Sample spectrogram of a non-expert (difficulties/CA)

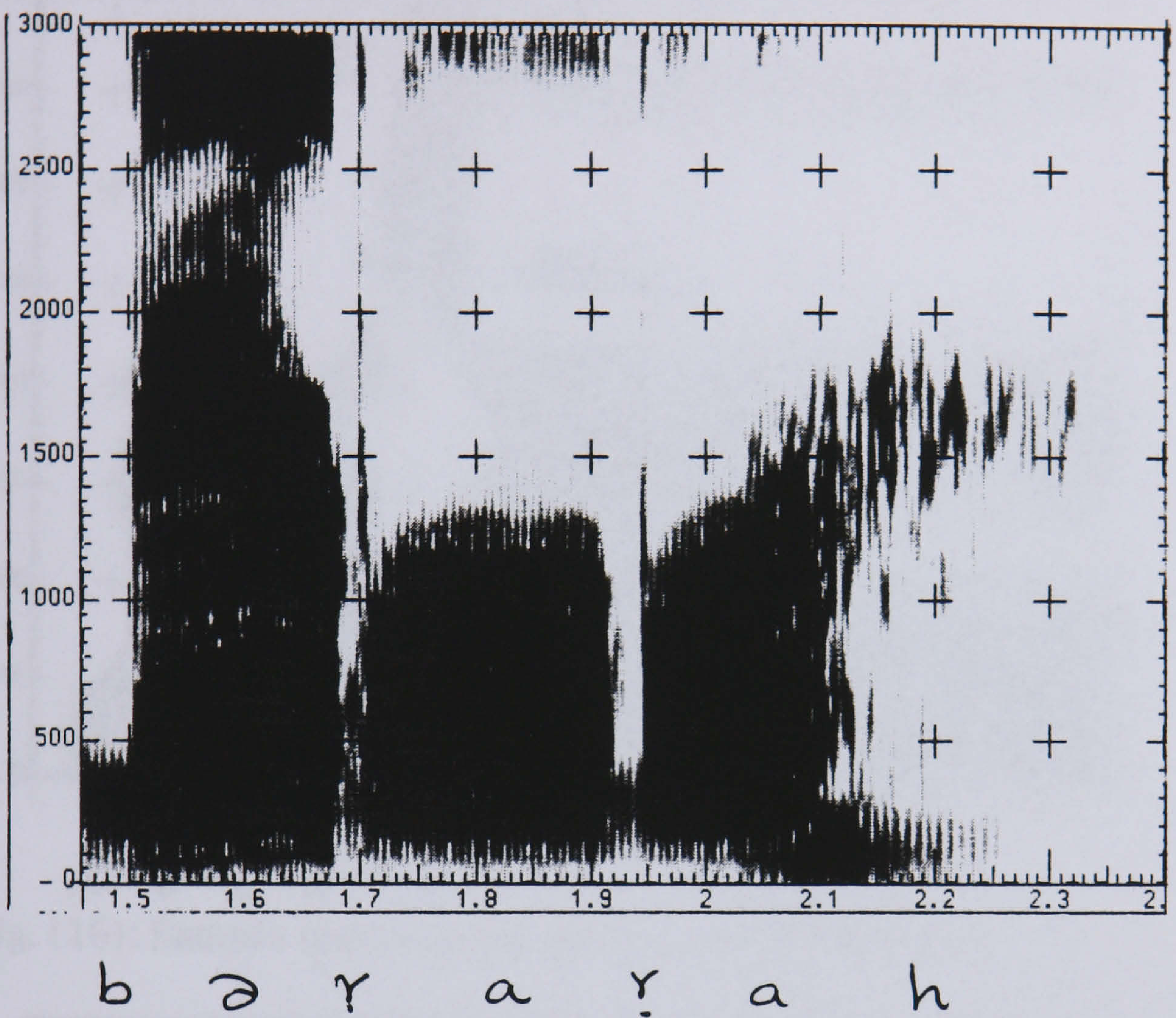


Fig. (14): Sample spectrogram of an expert (difficulties/CA)

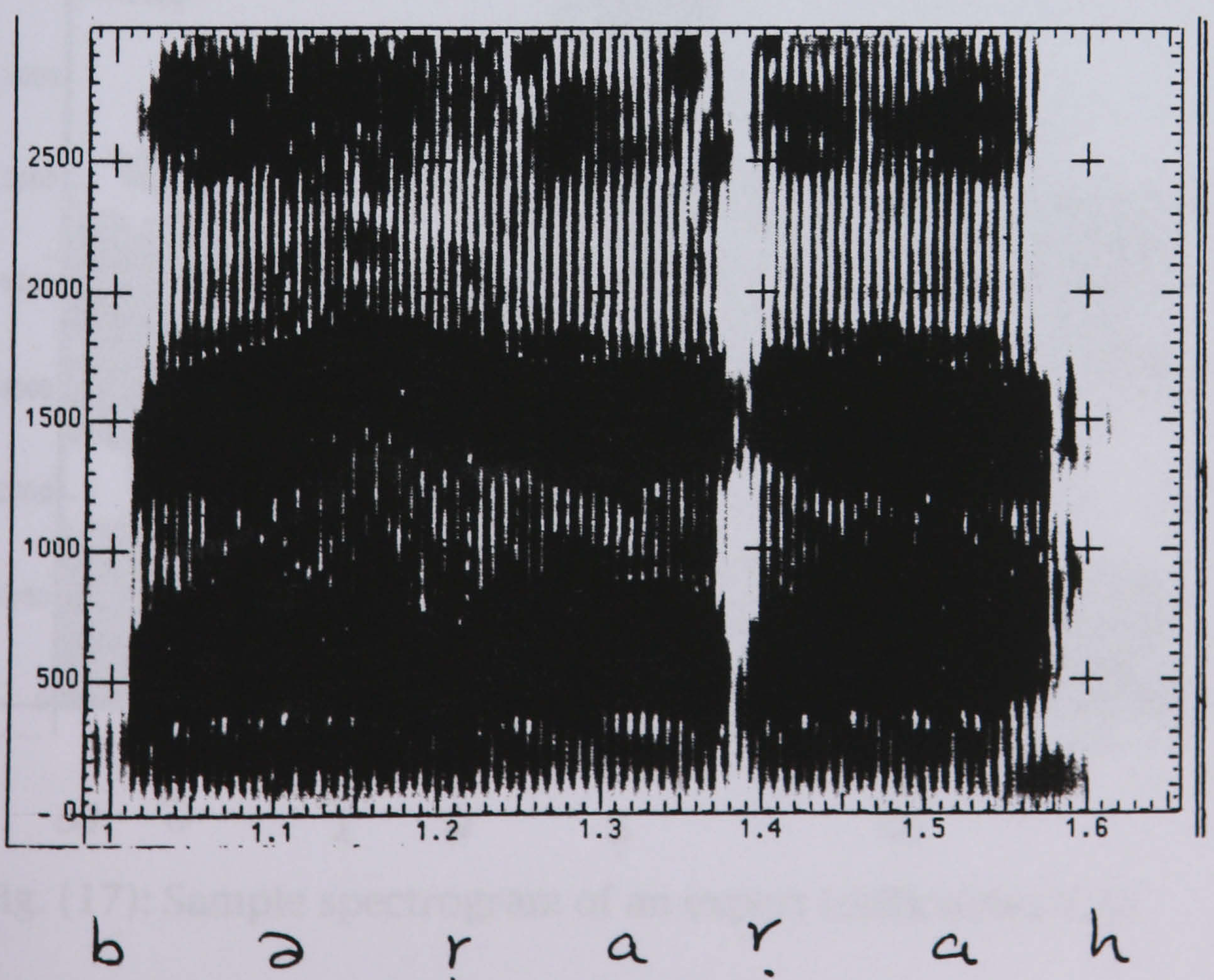


Fig. (15): Sample spectrogram of a non-expert (difficulties/CA)

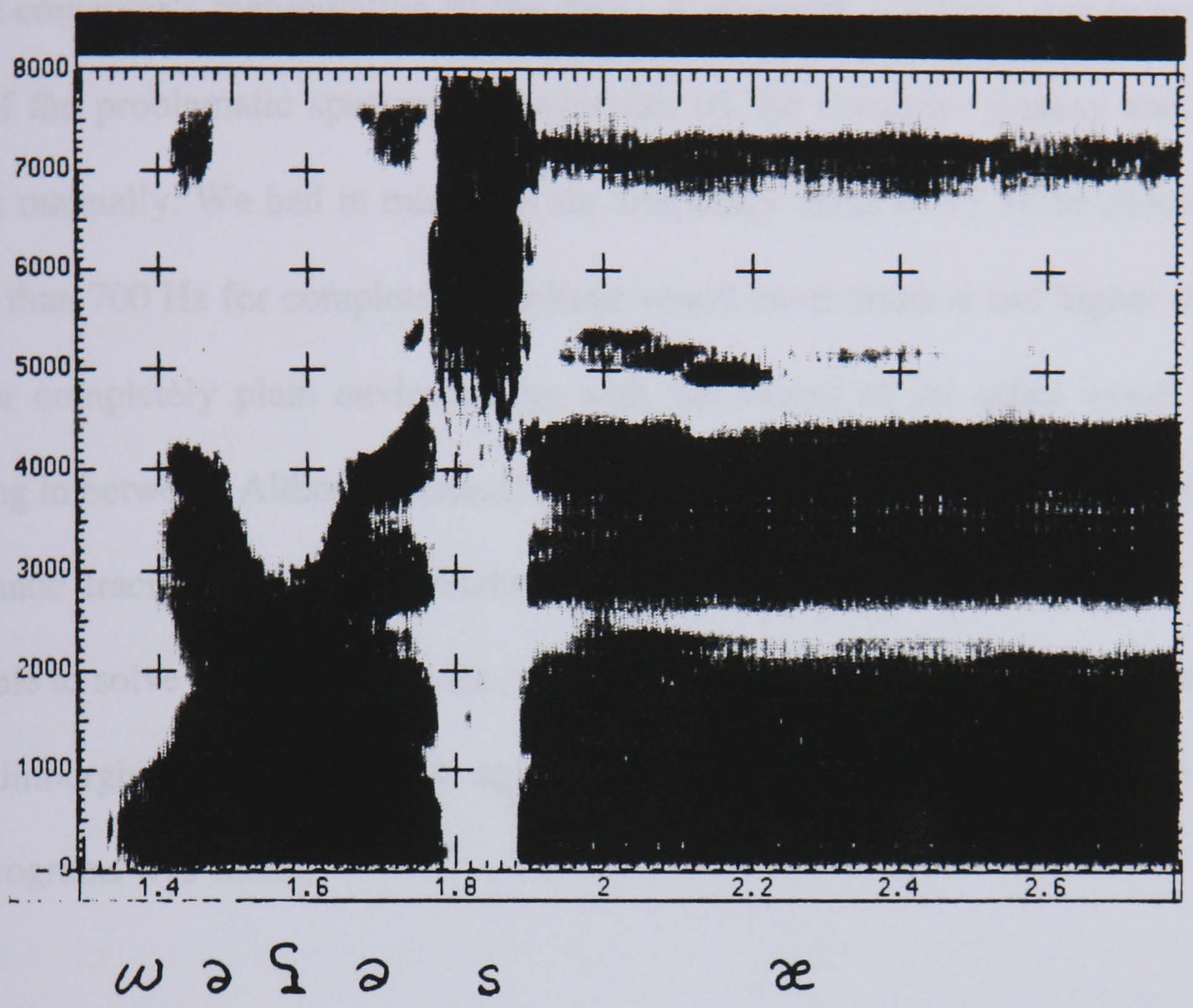


Fig. (16): Sample spectrogram of an expert (difficulties/CA)

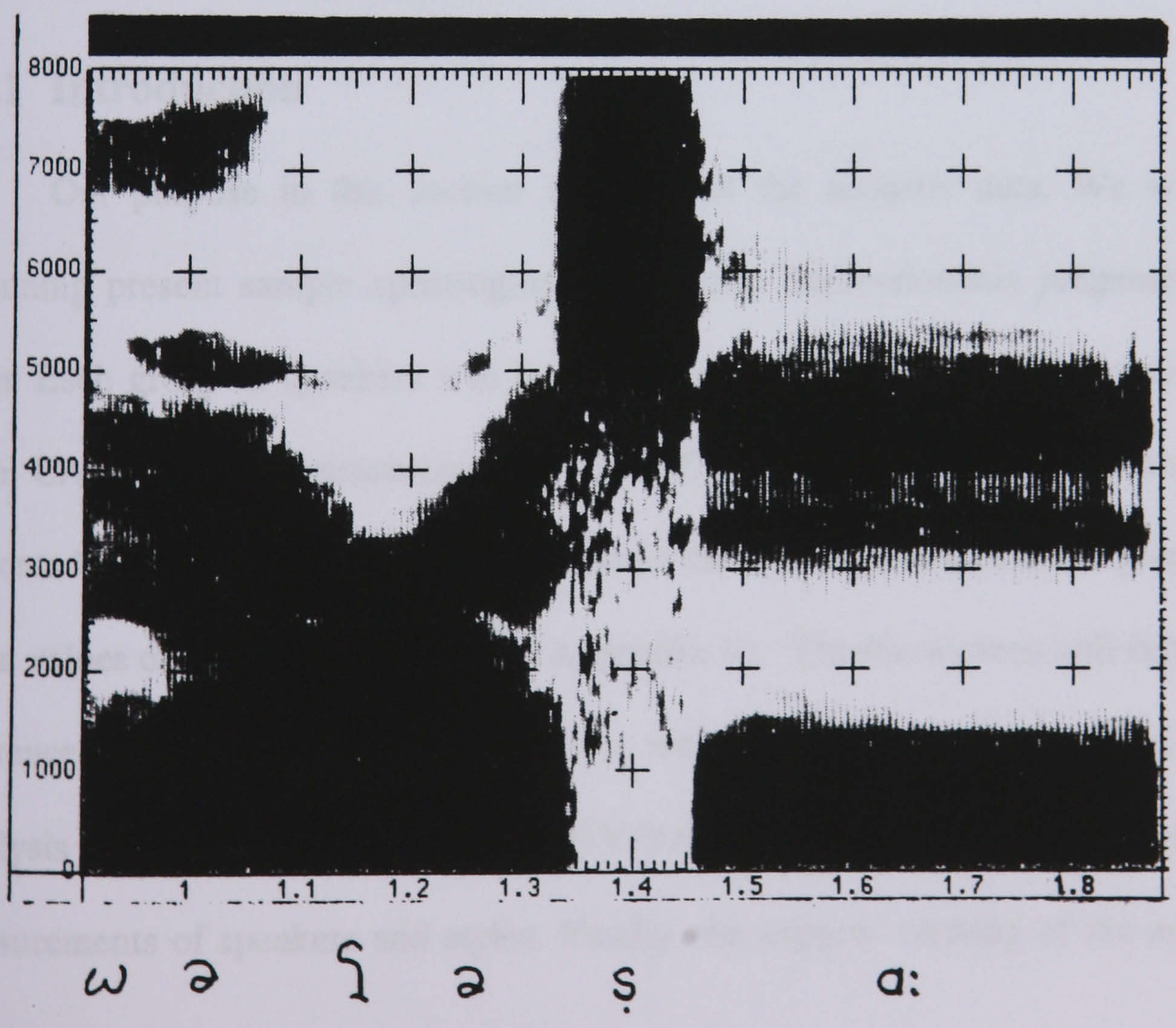


Fig. (17): Sample spectrogram of an expert (difficulties/CA) in a fairly confusing way so that it was not possible to identify F2 precisely by relying on the computer's manipulation of the data. A practical solution was to enlarge the size of the problematic spectrogram windows on the computer display and trace F2 values manually. We had in mind that the frequency value of F2 value should not get lower than 700 Hz for completely emphatic vowel environments and higher than 2000 Hz for completely plain environments with the values of the other vowel contexts ranging in between. Although manual tracing of formant values was not as objective as automatic tracings we were unfortunate to have no other alternatives. It was not possible to solve the problem at the laboratory or get the subjects (who were not living in Edinburgh) to be recorded again. In any case, the number of the unclear spectrograms was small.

4.2 Results and discussion

4.2.1 Introduction

Our purpose in this section is to report the acoustic data. We will at the beginning present sample spectrograms and make impressionistic judgements about them. Each group of speakers will be discussed separately before we compare them. Both CA and MSA measurement in PP/EE and EP/PE vowel contexts will be presented and compared. It should be noted that all the measurements presented are mean values of raw acoustic data (see Appendix V). The discussions will further make reference to results of statistical analyses which were primarily based on two-way Analysis of Variance (henceforth ANOVA) which was used to compare the measurements of speakers and styles. Finally, the experts' ranking of the non-experts will be discussed with a special treatment of the correlation between the acoustic measurements and the ratings.

4.2.2 The experts

4.2.2.1 Introductory remarks

Before presenting the acoustic measurements and the results of the statistical analysis of the experts' data we will explain briefly the overall difference between the four vowel contexts examined: PP, EE, EP and PE for this category of speakers. Figures (18), (19) and (20) show three spectrograms of the utterances *'atāka* 'he came to you', *ṭaghā* 'he exceeded bounds' and *ṭabaqan* 'stage/layer' when they were recited by the an expert (CA). Impressionistically, in a completely plain context where the consonants are /ʔ/ and /t/ the frequency value of the second formant of the vowel is as high as approximately 1700 Hz (Fig.18). By contrast, the formant is depressed/lowered to reach the frequency value of 900 Hz when it is preceded and followed by the emphatics /ṭ/ and /ʁ/ (Fig. 19). So, the difference value between the two frequency measurements is about 800 Hz.

While both the onset and offset of the vowel are either raised or lowered in the above contexts, only one vowel position is lowered in the EP and PE contexts. These findings are consistent with those of other phoneticians (e.g. Al-Ani 1970 and El-Dalee 1984). But it is worth noting that in Fig. (20) the transition patterns of the second formant are not symmetrical, and that in the PE context there exists something

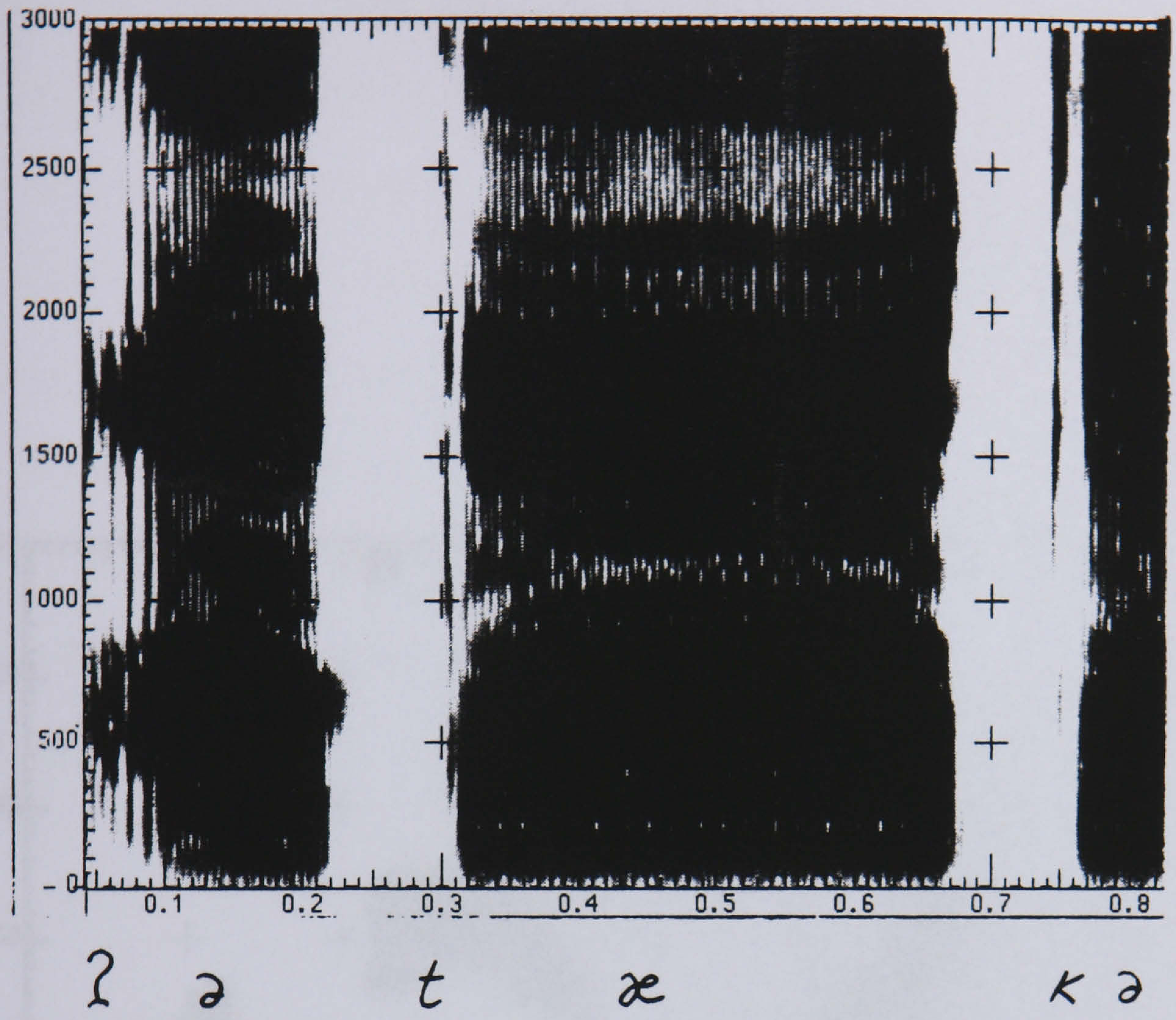


Fig. (18): Sample spectrogram of an expert (CA/PP: *'atāka* 'he came to you')

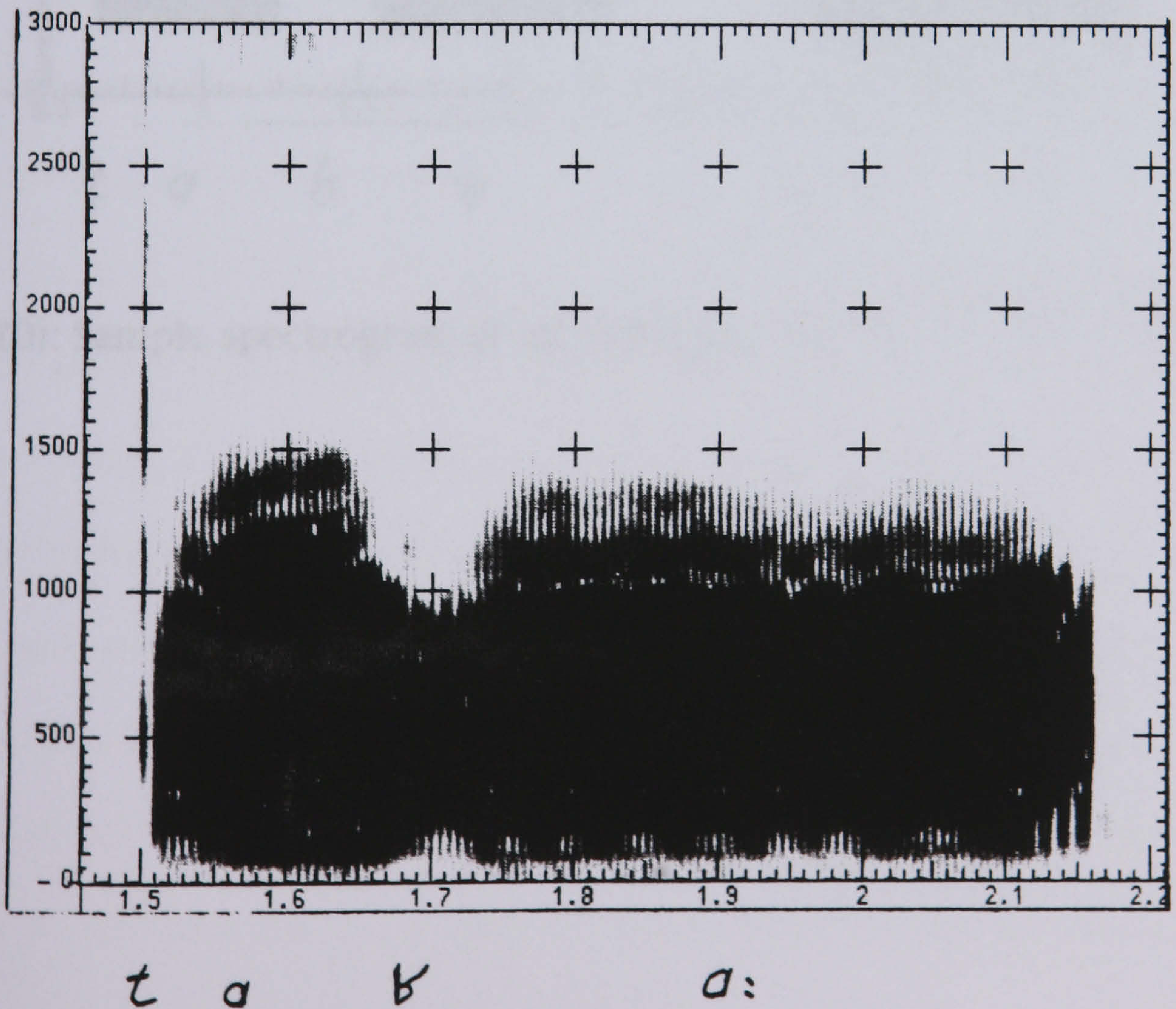


Fig. (19): Sample spectrogram of an expert (CA/EE: *ṭaghā* 'he exceeded bounds')

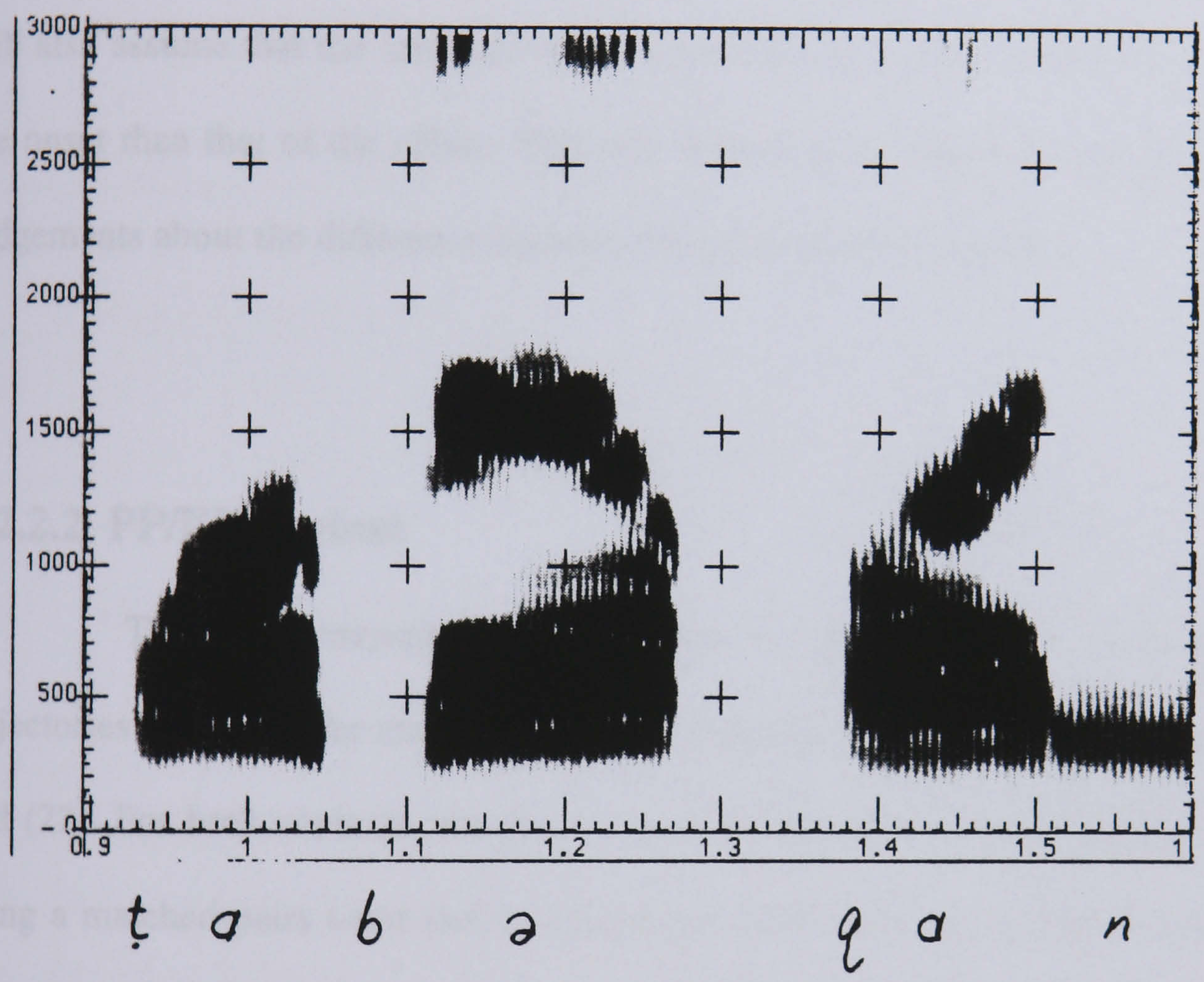


Fig. (20): Sample spectrogram of an expert (CA/EP-PE *ṭabaqan* 'stage/layer') that looks like an elbow whose centre is the middle of the vowel. Unfortunately, we could not find an appropriate way to quantify the elbow, and we were also unable to justify its existence. However, it was possible to measure the asymmetry between onsets and offsets of the vowels in both contexts as it will be shown later. In the meantime, we shall assume that the asymmetry could reflect the plainness of the vowel in the PE context unlike in the EP context where the vowel is strongly emphatic. We will also assume that the midpoint value in the former context is closer to the value of the onset than that of the offset. That will further give support to our impressionistic judgements about the difference between the two vowel trajectories.

4.2.2.2 PP/EE context

The PP/EE measurements are shown in Tables (7) and (8) and the speakers' trajectories (based on the mean values of the measurements) are shown in Figures (21) and (22). For both contexts, the mean values of the onset and offset were compared using a matched-pairs t-test and no significant difference was found between the two vowel positions. In other words, the preceding and following plain segments seem to have the same acoustic effect on the vowel which could imply that the vowel does not undergo change throughout its duration. There is a big difference between the PP and EE measurements. In other words, the speakers exhibit a large F2 difference between plain and emphatic articulations. We observe that the two styles are clearly differentiated here, unlike in the PP context.

Fig. (23) expresses the overall difference between PP and EE trajectory patterns. It will be seen later that all the speakers regardless of their expertise deviate from a

Spr	Style	Onset	Mid	Offset	Mean	Diff
E1	CA	1525(230)	1597(226)	1604(245)	1575	
	MSA	1373(411)	1564(143)	1571(178)	1502	73
E2	CA	1642(248)	1696(219)	1579(306)	1639	
	MSA	1604(294)	1695(190)	1640(200)	1646	7
E3	CA	1410(184)	1445(138)	1527(191)	1460	
	MSA	1450(234)	1501(148)	1525(120)	1492	32
E4	CA	1582(244)	1651(167)	1658(200)	1628	
	MSA	1434(304)	1588(233)	1637(218)	1553	75
E5	CA	1361(272)	1399(186)	1327(199)	1362	
	MSA	1366(252)	1417(174)	1388(144)	1390	82
E6	CA	1507(246)	1502(204)	1529(274)	1484	
	MSA	1520(258)	1621(259)	1609(283)	1583	99

Table (7): PP measurements of the experts

Spr	Style	Onset	Mid	Offset	Mean	Diff
E1	CA	879(66)	963(69)	907(84)	916	
	MSA	958(38)	1012(59)	986(110)	985	69
E2	CA	970(66)	1083(58)	1001(133)	1018	
	MSA	1037(100)	1109(85)	1037(61)	1061	43
E3	CA	973(63)	1008(67)	995(113)	992	
	MSA	1118(111)	1151(53)	1130(62)	1133	141
E4	CA	862(129)	992(130)	939(160)	931	
	MSA	957(128)	1120(93)	1037(164)	1038	107
E5	CA	889(107)	912(95)	875(52)	892	
	MSA	935(181)	1020(126)	957(65)	970	78
E6	CA	959(96)	1038(119)	898(100)	965	
	MSA	1027(58)	1068(89)	969(68)	1021	56

Table (8): EE measurements of the experts

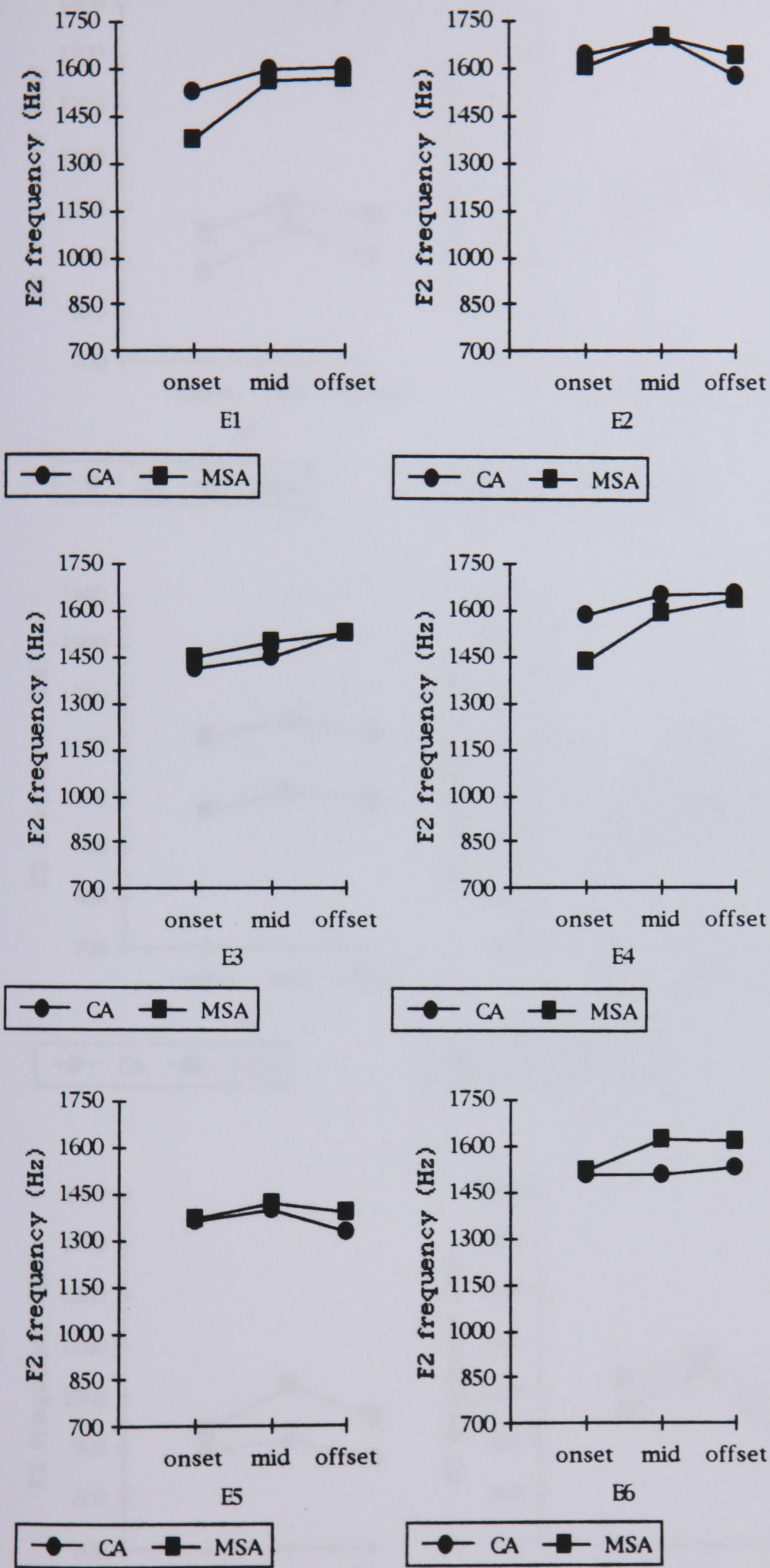


Fig. (21): PP trajectories of the experts

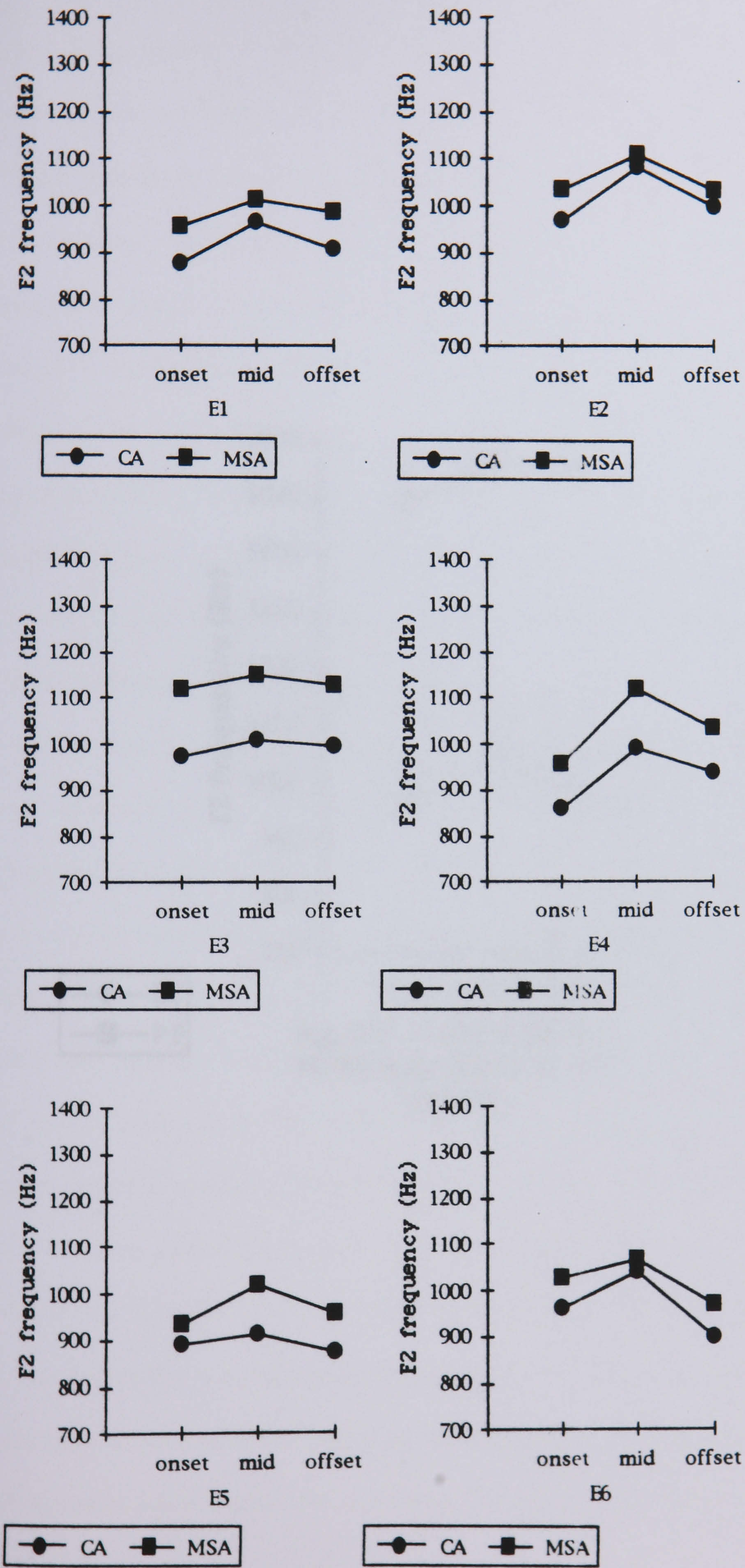


Fig. (22): EE trajectories of the experts

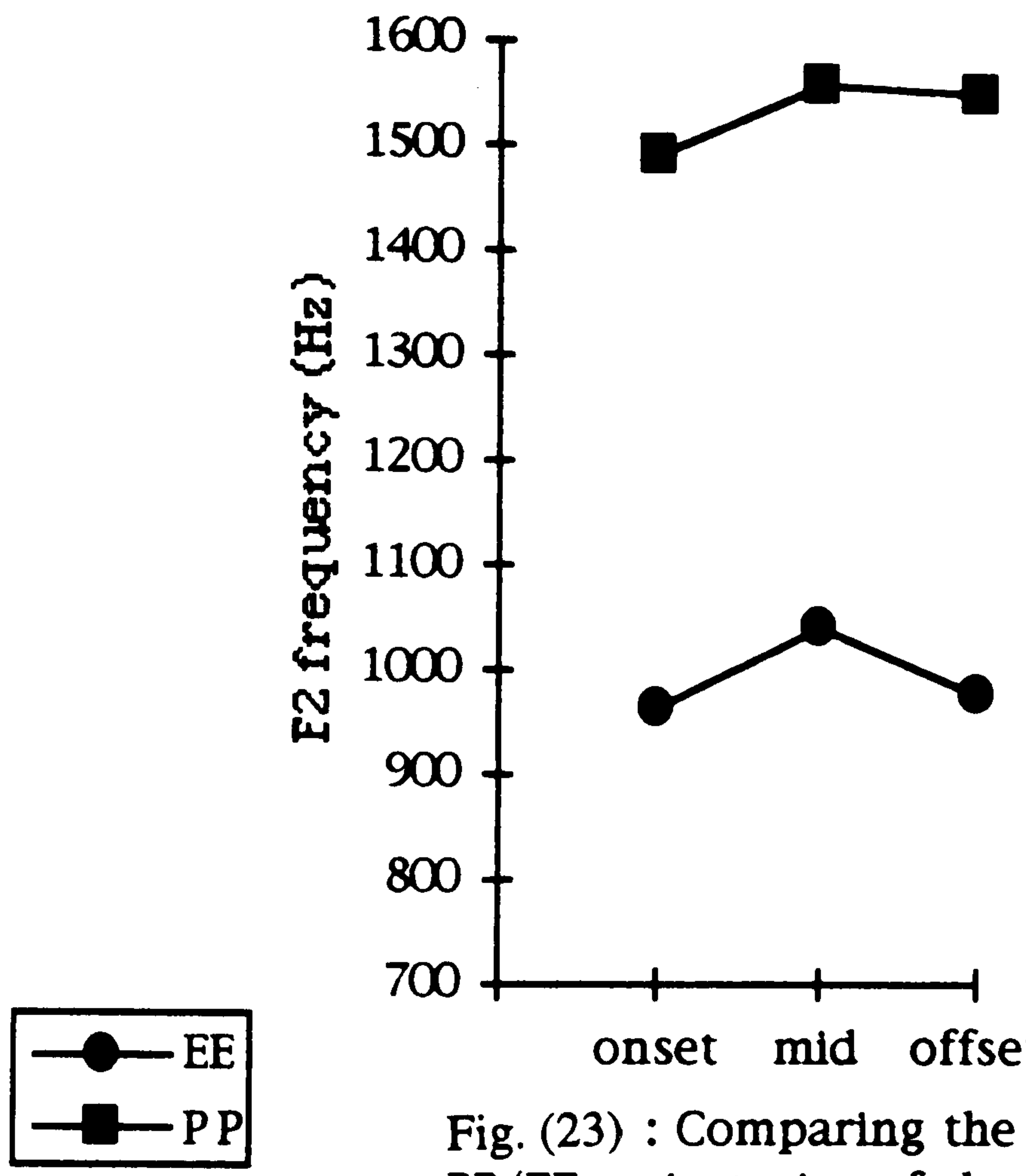


Fig. (23) : Comparing the PP/EE trajectories of the experts completely plain context - which is the baseline or reference point for all the trajectories - by the lowering of the second formant in a variety of emphatic contexts. Both PP/EE trajectories are characterized by a peak in the middle, which is even clearer in the latter. Unfortunately, no clear explanation could be found for why these trajectories have a peak. One possible explanation, however, is that the peak might be the result of an aerodynamic effect during the production of the vowel that resulted in an increase in its amplitude which was reflected acoustically by the peak in the midpoint. In other words, the peak might be the result of a low effect level of physiological origin because of the pushing up of the airstream during the production of the vowel. If these expectations are correct it is not indicative of any phonetic or phonological characteristics of the styles investigated.

Let us now discuss the speakers and styles in further detail. Objectively speaking, we should bear in mind that experts are ordinary human beings with human vocal capacities even though they have learnt a special language skill which ordinary speakers may not have mastery in. In other words, it is implausible to expect that all experts' performances must be identical. Speakers differ in respect of their linguistic capacities and, indeed, in other non-verbal activities. There may be cases where experts' performance becomes significantly different depending on, for instance, how often they practice recitation according to the principles they have themselves acquired. Thus, an expert involved in intensive recitation classes may be closer to correct/ideal recitation that someone who occasionally teaches recitation. Similarly, an expert who is awarded a certificate by someone who is regarded an authority in the field may have a better skill than someone whose teacher is an unknown expert. But the differences between experts are expected to be smaller than between experts and ordinary speakers simply because there exists a general standard norm which is learnt and taught by experts.

Another problem relevant to the amount of difference between any speakers (and not necessarily the experts) is the normalization of their measurements which was not dealt with in the present study (see section 4.1.6). Some differences between the experts may be found significant for completely non-linguistic factors such as the different shapes of their vocal tracts. The results of ANOVAs were based on raw data and real measurements that we did not normalize in order to separate between linguistic and non-linguistic measurements. There was no clear method of how to do so. Therefore, it was decided to use the raw measurements. That may be part of the reason that the statistical analyses sometimes gave results that were not consistent with our impressionistic views about similarities and differences between the speakers. The results of ANOVAs are reported below.

We used ANOVA for both the PP and EE vowel contexts. The independent variables for each context were speaker, style and context and the dependent variable was the mean of the onset, midpoint and offset of the vowel. For the PP context, ANOVA showed a significant main effect for speaker ($F(5,84) = 3.43$, $p < .01$) but it did not show a significant main effect for style, and there was no significant interaction between speaker and style. For the EE context, ANOVA showed a significant main effect for both speaker ($F(5,84 = 6.70$ $p < .001$) and style ($F(5,84) = 27.06$ $p < .001$), and there was no significant interaction between the two variables. This implies that, unlike the EE context, there is not a real difference between CA and MSA in the PP context and that the two styles get closer if the vowel is completely plain.

4.2.2.3 EP/PE contexts

Tables (9) and (10) below present the mean onset, mid and offset of the EP/PE measurements of the experts and the graphs in Figures (24) and (25) (based on mean values of the measurements) show their EP/PE trajectories. The difference between the vowel's onset and offset (ΔF2) for each style is presented in the last column in the tables. It can be noted that the onset is the lowest F2 value and the offset is the highest, or the other way round, depending on the position of the emphatic consonant. The midpoint ranges between the two vowel positions, but it is closer to the onset value in the PE than in the EP context. That is consistent with the impressionistic observation that the EP trajectories exhibit a straight line from the onset to the offset. For the moment, we will not discuss the elbows which some speakers (e.g. E1 and E4) exhibit in their PE trajectories (especially in CA), and concentrate on ΔF2.

In the EP context, CA is characterized by a lower onset and a higher offset than MSA for all speakers except E6 who exhibits similar trajectories for both styles. This suggests that the majority of our speakers distinguish between CA and MSA by increasing the size of the emphatic gesture for the former style. Presumably the larger the difference between ΔF2 values the clearer the difference between the two styles. There is similarity between the EP and PE contexts in the sense that the bigger the ΔF2 value for CA the clearer the difference between the two styles. On the basis of individual differences in the latter context it seems that some experts (e.g. El and E6) do not explicitly distinguish between CA and MSA. They might have applied recitation rules to ordinary reading passages. Other speakers seem to have drawn a clearer boundary between CA and MSA. We would thus expect individual differences

Spr	Style	Onset	Mid	Offset	Δ F2	Δ F2 diff
E1	CA	902 (63)	1017 (135)	1296 (339)	394	
	MSA	918 (50)	1026 (114)	1224 (364)	306	88
E2	CA	959 (149)	1144 (123)	1322 (301)	363	
	MSA	1008 (279)	1149 (175)	1241 (298)	233	130
E3	CA	967 (67)	1065 (130)	1231 (263)	264	
	MSA	1068 (80)	1129 (135)	1175 (299)	107	157
E4	CA	811 (142)	1051 (174)	1296 (272)	485	
	MSA	910 (239)	1116 (234)	1270 (279)	360	125
E5	CA	759 (116)	970 (102)	1092 (306)	390	
	MSA	893 (128)	995 (164)	1157 (256)	264	69
E6	CA	897 (108)	1086 (139)	1295 (336)	398	
	MSA	890 (125)	1108 (174)	1326 (376)	436	38

Table (9): EP measurements of the experts

Spr	Style	Onset	Mid	Offset	Δ F2	Δ F2 diff
E1	CA	1389 (142)	1250 (99)	949 (79)	390	
	MSA	1366 (217)	1208 (151)	1011 (72)	355	35
E2	CA	1329 (196)	1315 (112)	1054 (88)	275	
	MSA	1256 (146)	1212 (109)	1071 (114)	185	90
E3	CA	1288 (122)	1249 (67)	1034 (91)	254	
	MSA	1226 (139)	1177 (99)	1107 (56)	119	135
E4	CA	1480 (151)	1462 (122)	1100 (155)	380	
	MSA	1396 (202)	1339 (116)	1226 (93)	170	210
E5	CA	1265 (248)	1161 (167)	883 (167)	382	
	MSA	1183 (224)	1102 (136)	946 (114)	237	145
E6	CA	1415 (236)	1333 (111)	984 (140)	431	
	MSA	1408 (166)	1273 (126)	995 (117)	413	18

Table (10): PE measurements of the experts

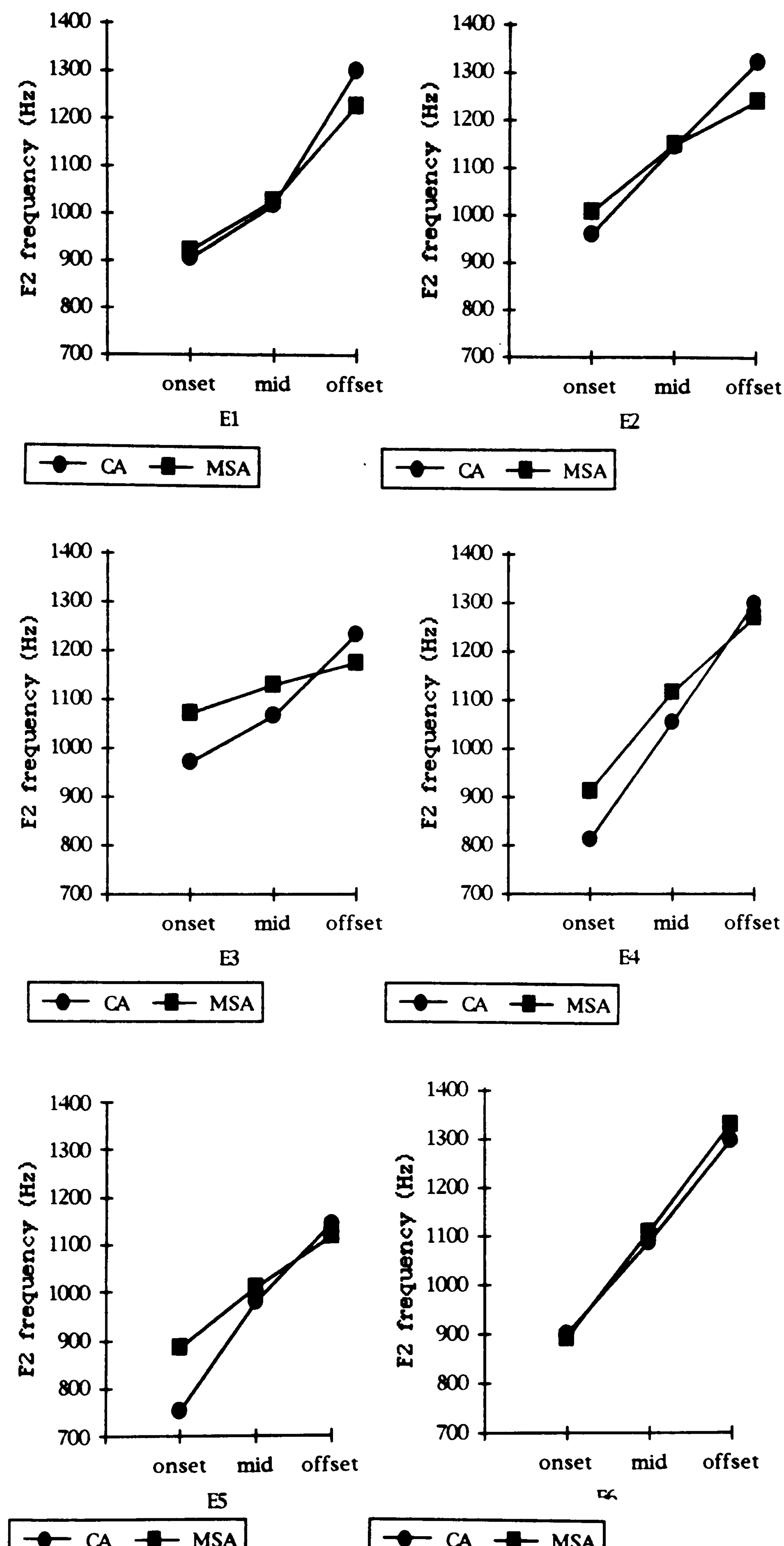


Fig. (24): EP trajectories of the experts

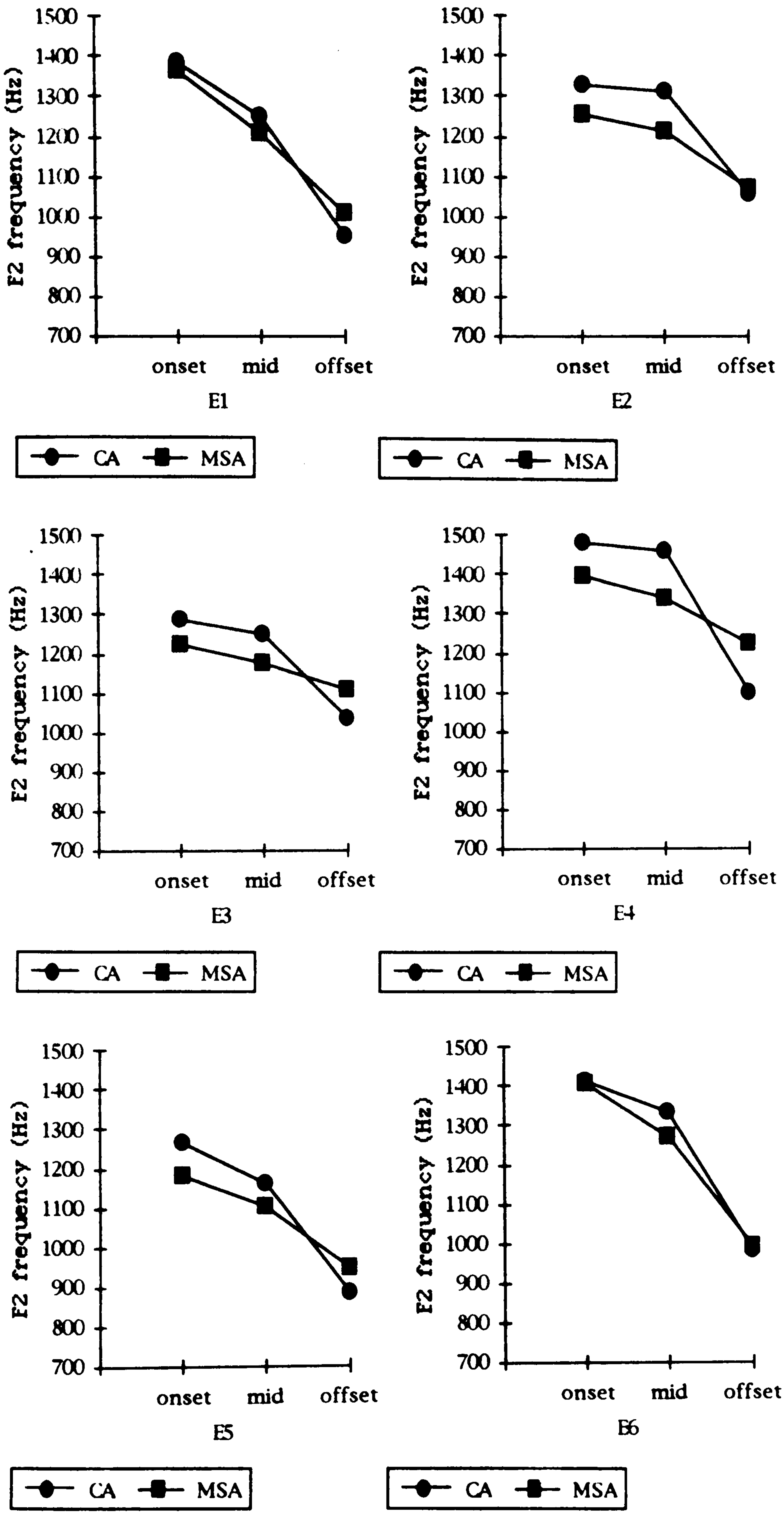


Fig. (25) PE trajectories of the experts like these to exist among speakers who vary in the extent to which they apply recitation rules to MSA passages.

Fig. (26) expresses the overall difference between the EP and PE trajectory patterns of the experts (based on the mean values of the speakers' measurements). The trajectories cross between the midpoints and offsets of the vowels, but the crossing occurs at some point towards vowels' offsets. The onsets, and to a smaller degree, the midpoints, are clearly pulled apart and the distance between the onsets is bigger than the one between the offsets. That could be evidence for the perseverative effect of emphasis which is apparently greater than the anticipatory effect. In other words, the vowel in the PE context is presumably plain.

Let us now come back to the point we raised before about the elbows seen in the EP and PE contexts. We found no way to quantify those elbows and we are not quite sure what the sharp elbows in the PE trajectories of the experts (e.g. E4) actually reflect. For example, by considering the spectrogram in Fig. (20) above (the utterance *ṭabaqan* 'stage/layer') we observe that the main part of the change from the beginning to the end of the vowel in the PE context actually happens in the second half of its duration, unlike the vowel in the EP context where the change begins right in the first half of the vowel. Acoustically, the first half of the vowel in the PE context remains as high as possible before the speaker makes up what looks like an abrupt change in the transition pattern of F2. Therefore, the value of the midpoint of the vowel is close to the initial value. That is why when the EP/PE trajectories were plotted in Fig. (26) above the midpoints of the vowel trajectories did not cross to make an 'X' shape-like (unlike with the non-experts as will be shown below). This does not merely give the

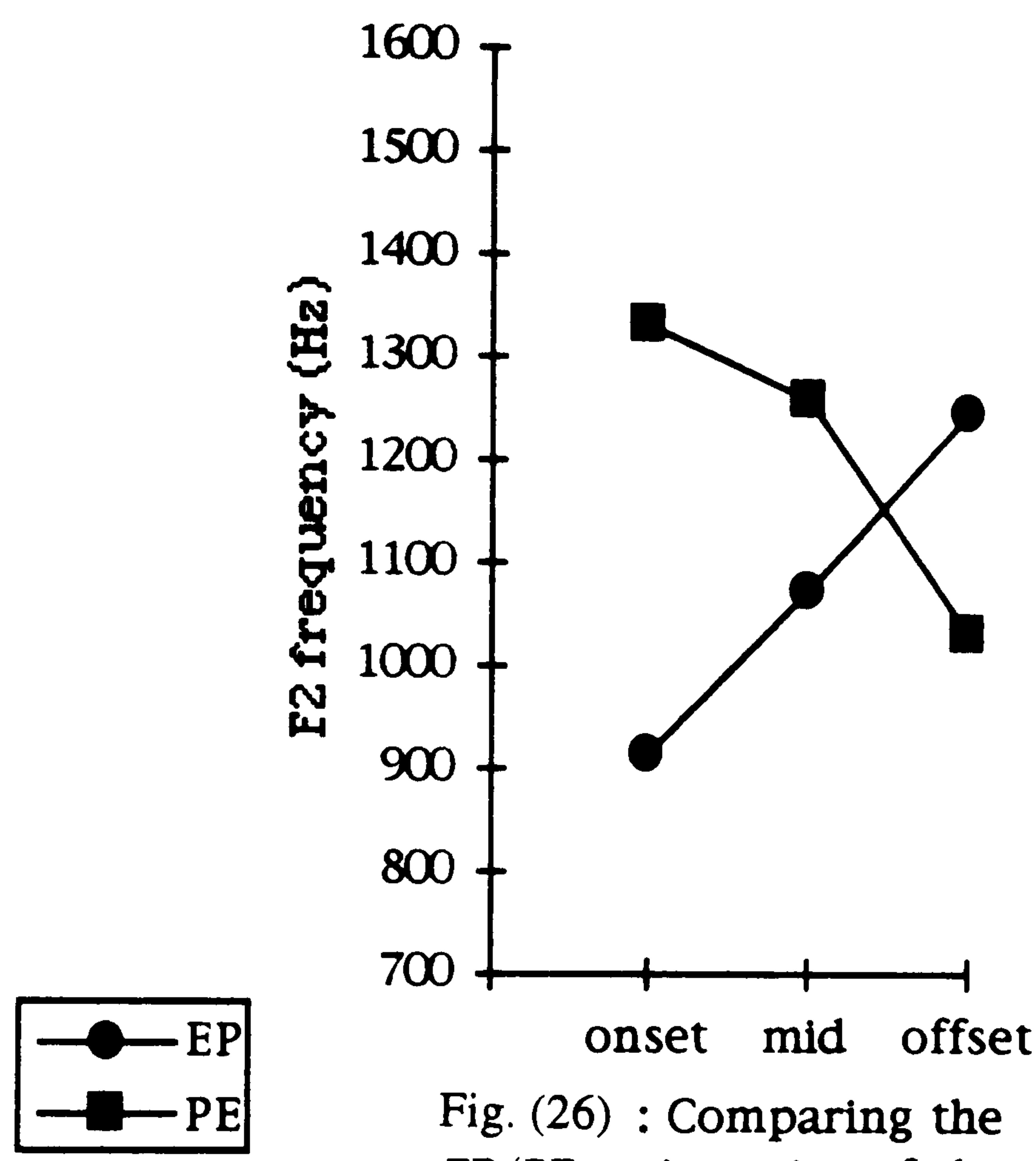


Fig. (26) : Comparing the EP/PE trajectories of the experts indication that the quality of the vowel is directly influenced by the feature of the preceding consonant, but it also shows that emphatic spread in the recitations of the experts is perseverative. In other words, if the vowels in the EP/PE contexts were similarly affected by the neighbouring emphatic consonant there would be no asymmetry in time between the onsets and offsets of the trajectories and the midpoints would not be clearly pulled apart.

Therefore, it might be appropriate to quantify the asymmetry. The formula below can be used to compute the difference between the midpoints in the PE/EP trajectories and divides the outcome by the difference between the onsets of both trajectories. 'A' stands for the value of the asymmetry. In theory, if we had perfectly perseverative/anticipatory symmetrical formant trajectories we would expect the formula to give a value about zero. But if we had a strong bias towards perseverative emphatic assimilation we would expect a positive value and if we had a strong bias towards anticipatory emphatic assimilation we would expect a negative value. The values of the asymmetry are indicated in Table (11) below. We can assume that E4, who has the closet value to +1, is probably closer to the ideal *tajwid* target than his colleagues while E5 whose value is the furthest from +1 is the least successful in achieving that target.

$$A(\text{symmetry}) = (\text{mid PE}) - (\text{mid EP}) / (\text{onset PE}) - (\text{onset EP})$$

The overall picture found so far shows that the speakers follow similar EP and PE trajectory patterns for both CA and MSA, and that they normally differentiate between the two styles similarly by maintaining a larger $\Delta F2$ for CA. There is also asymmetry in time between the beginning and end of the vowels, and the midpoints of the trajectories do not cross. Rather, the vowel's middle value is constantly more like the initial value so that it could remain as high as possible before the trajectory gets lowered. That could imply that the experts' emphatic assimilation follows a single perseverative direction and that the vowel resist emphasis in the PE context (see Chapter Five for discussion of coarticulation resistance).

Speaker	A	
	CA	MSA
E1	0.48	0.41
E2	0.46	0.25
E3	0.57	0.30
E4	0.61	0.46
E5	0.38	0.12
E6	0.48	0.32

Table (11): Values representing the asymmetry (experts)

Using speaker, style and context as independent variables and $\Delta F2$ value as dependent variable, ANOVA showed no significant main effect for speaker and style and no significant interaction between the two variables in the EP context. This probably expresses similarity among speakers. Using the same variables with the PE context, however, ANOVA showed a significant main effect for speaker ($F(5,84) = 2.78$, $p < .05$) and style ($F(5,84) = 6.33$, $p < .05$) while there was no significant interaction between the two variables. The distinction between styles is, therefore, clearer in the PE context. On the other hand, using the value representing the asymmetry as dependent variable instead of $\Delta F2$ no significant main effect for speaker and style and also no significant interaction between the two variables were found.

4.2.2.4 Comparing the four trajectories of the experts

It is primarily the existence of the E target which leads to the contrast between the PP and other trajectories, especially the EE trajectory which is the lowest among all. On the other hand, the E target also motivates speakers to distinguish between CA and MSA. $\Delta F2$ is thus consistently larger for CA and the mean values in the EE context are consistently lower for this style. The difference between the CA and MSA is thus more recognizable/identifiable in emphatic environments, and it tends to disappear in PP environments. This suggests that the PP trajectory - which is the highest among the four trajectories - can be considered the baseline or reference point which the speakers deviate from to produce the emphatic gesture.

The asymmetry between the onsets and offsets of the vowels in the EP/PE contexts and the finding that the midpoints are consistently pulled apart and never cross could well point to a perseverative emphatic assimilation in the experts' recitations, which is probably the result of applying a rule of a unidirectional spreading of emphasis in CA. The experts have probably learnt how to manage holding the steady-state of the section of the vowel for most of its duration before they make change from high to low F2. So, they attempt to avoid the effect of the upcoming emphatic gesture. But we should not, of course, discard the significance of $\Delta F2$ measurements because they reflect the size of the emphatic gesture in cases where the reciter spreads emphasis perseveratively. $\Delta F2$ in the PE context could also be important especially if one assumes that the larger its value the greater the speaker's resistance to the anticipatory emphatic spread.

The difference between the two E targets in the EE and EP trajectories could reflect the phonetic aspect of experts' recitations. F2 lowering must occur if the vowel is coming in the vicinity of an emphatic consonant. But since the EE context is completely emphatic F2 is even more lowered or depressed than in the EP context especially with CA. This observation is probably relevant to the hypothesis that phonetic targets are hyperarticulated (Lindblom 1990), a problem that will be addressed in Chapter Five. Since the difference between styles results from the size of the emphatic gesture which is larger for CA. The experts explicitly induce a larger emphatic gesture for CA than for MSA. They possibly draw a distinction between the different vowel contexts by giving a clear underlying specification to the E target(s) as to show the contrast between emphasis and plainness and between CA and MSA.

4.2.3 The non-experts

4.2.3.1 Introductory remarks

Consider the spectrograms of a non-expert in Figures (27), (28) and (29) below where /a/ is coming in the contexts PP, EE, EP and PE in recitation style. Fig. (27) shows that in a completely plain context F2 frequency value is as high as approximately 1500 Hz, but the formant raises about 100 Hz towards the end of the vowel. In Fig. (28) the second formant is extremely lowered to reach 1100 Hz

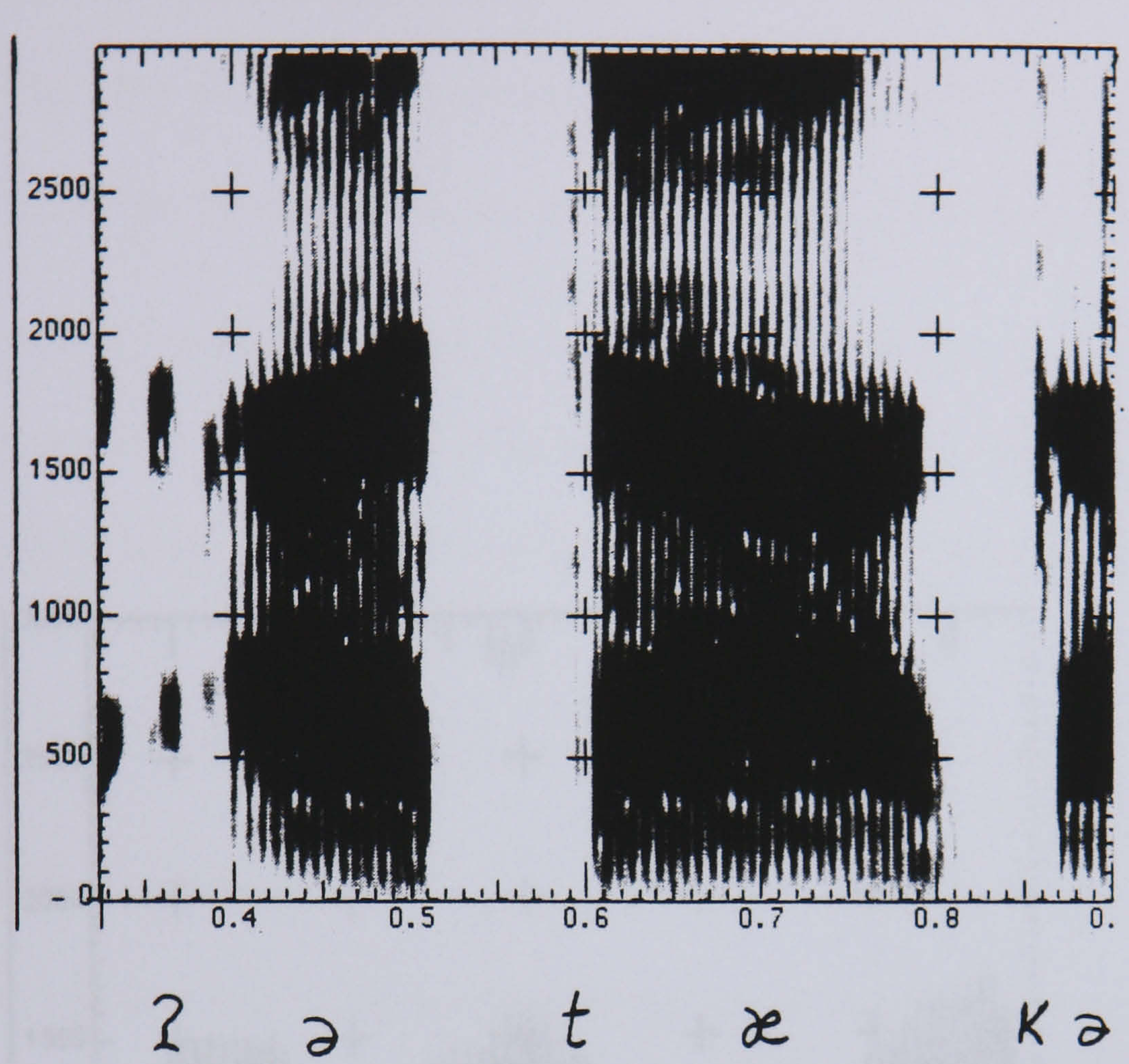


Fig. (27): Sample spectrogram of a non-expert (CA/PP:*ataka* 'he came to you')

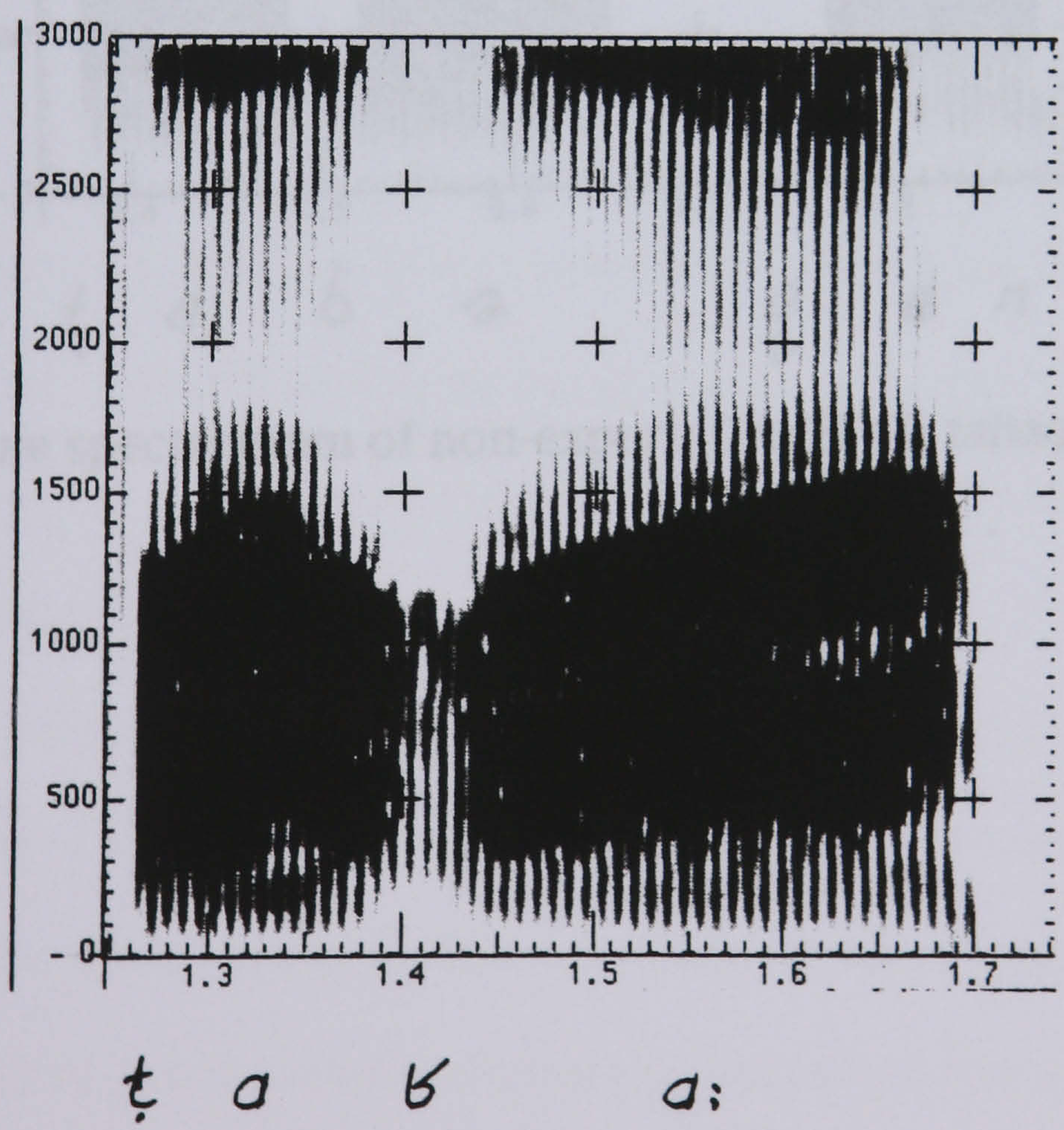


Fig. (28): Sample spectrogram of non-expert (CA/EE:*tagha* 'he exceeded bounds')

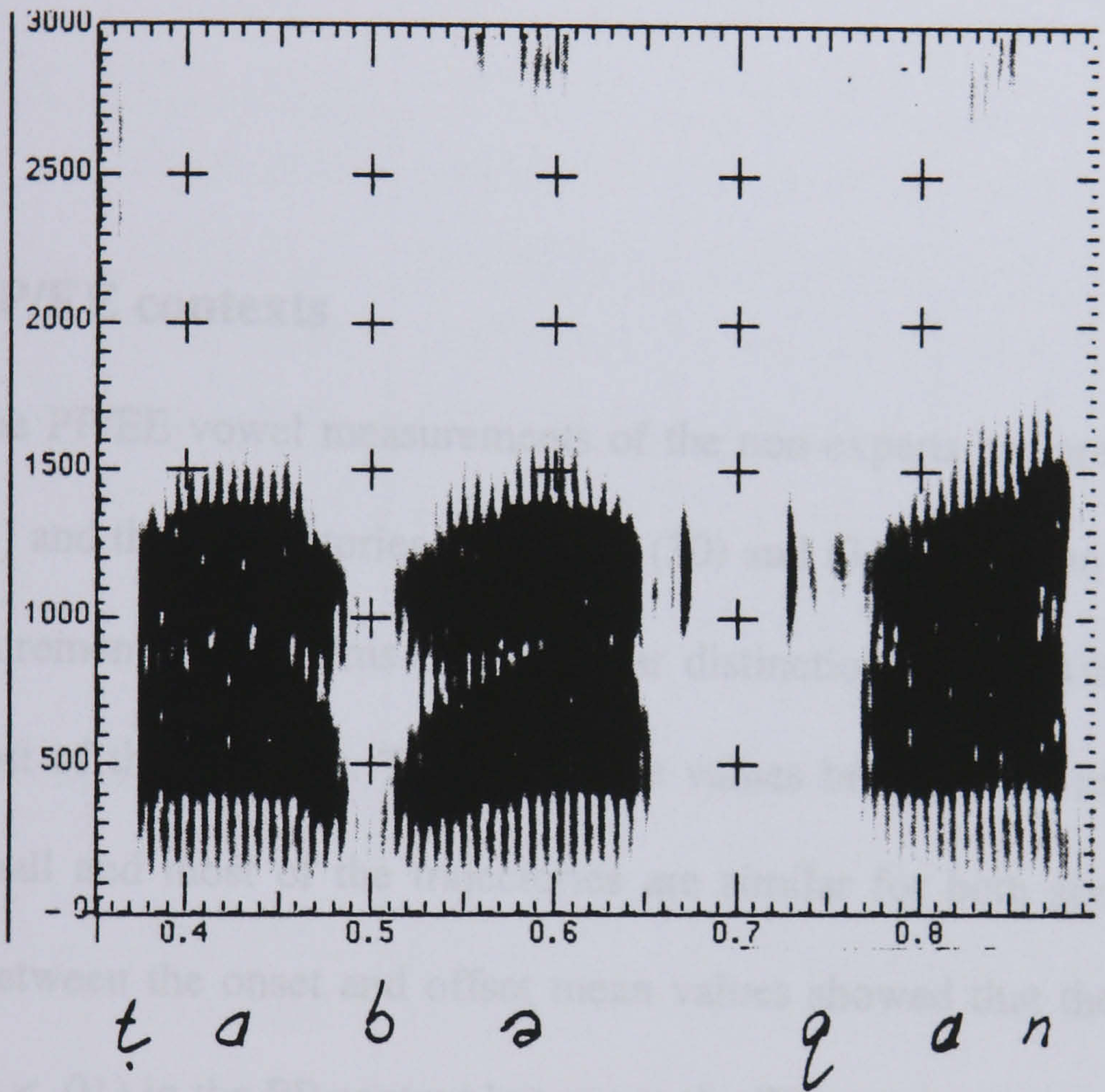


Fig. (29): Sample spectrogram of non-expert (CA/EP-PE *tabaqan* 'stage/layer') under the influence of the preceding and following emphatic consonants. By considering Fig. (29) we see no significant difference between the vowel before and after the consonants (emphatic /ṭ/ vs. plain /b/) although they presumably have different articulatory qualities. Generally, we assume that this speaker does not draw a clear contrast between emphatic and plain segments particularly when they occur in in the same word. In other words, he could have produced plain /b/ with some emphasis ([b]).

4.2.3.2 PP/EE contexts

The PP/EE vowel measurements of the non-experts are presented in Tables (12) and (13) and their trajectories in Figures (30) and (31) (based on the mean values of the measurements). It seems that no clear distinction is drawn between CA and MSA by most of the speakers. The difference values between the measurements are relatively small and most of the trajectories are similar for both styles. A matched-pairs t-test between the onset and offset mean values showed that the difference was significant ($p < .01$) in the PP context but not in the EE context (see section 4.2.4.4 for comments). There is a slight rise across the PP trajectory. Unfortunately, there is no obvious explanation for this.

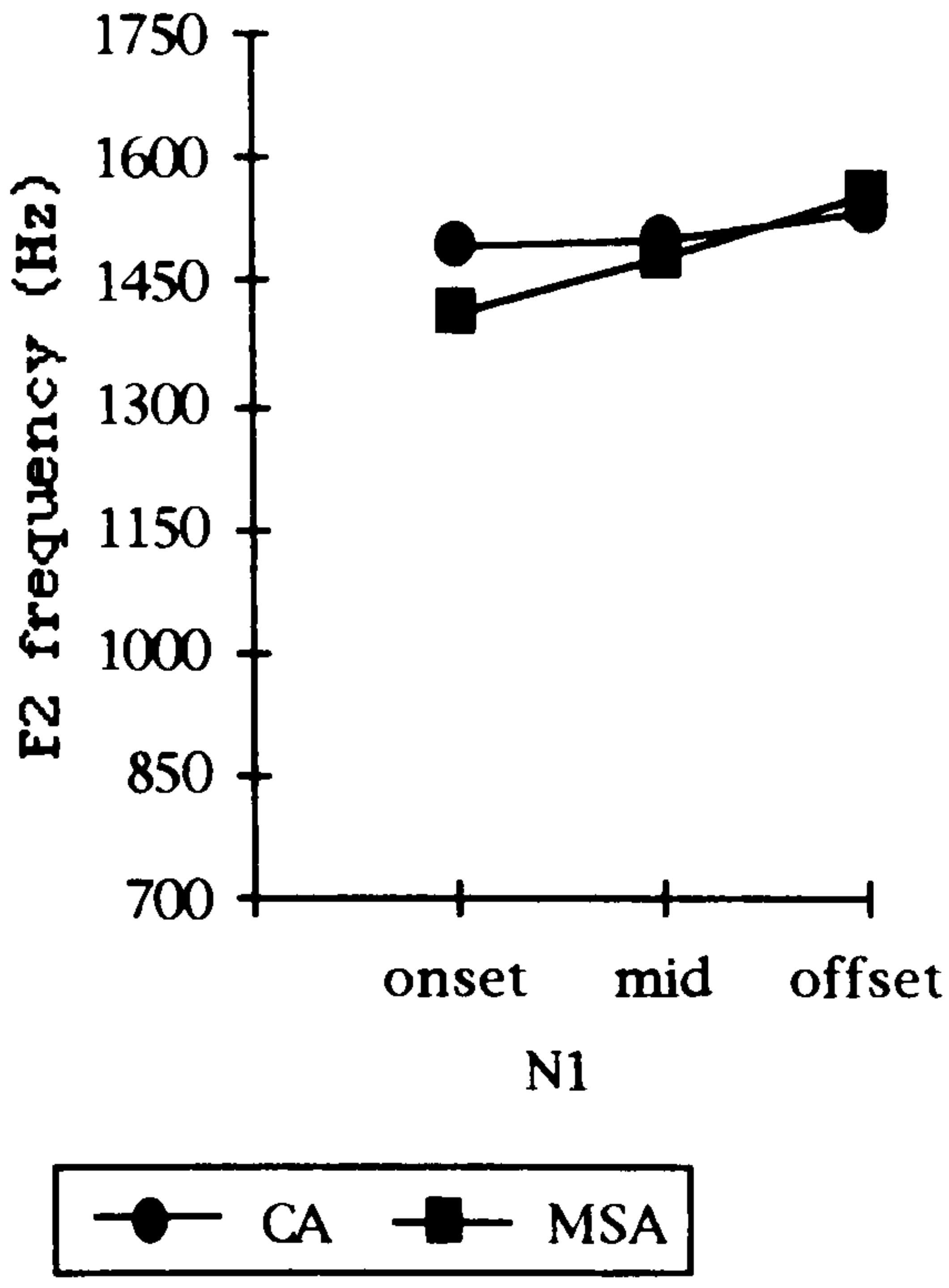
The main difference between the PP and EE trajectories is the overall extreme lowering of F2 frequency as indicated in Fig. (32) (based on the mean values of both styles for the non-experts). The values are far lower than those of the PP trajectories, implying that the non-experts make a clear contrast between emphasis and

Spr	Style	Onset	Mid	Offset	Mean	Diff
N1	CA	1492 (290)	1499 (243)	1531 (269)	1492	
	MSA	1412 (297)	1482 (236)	1556 (240)	1483	9
N2	CA	1531 (375)	1530 (251)	1576 (288)	1531	
	MSA	1474 (413)	1542 (240)	1611 (259)	1542	11
N3	CA	1361 (311)	1364 (203)	1385 (327)	1361	
	MSA	1321 (216)	1405 (200)	1381 (283)	1369	8
N4	CA	1473 (254)	1488 (219)	1455 (255)	1473	
	MSA	1320 (331)	1445 (243)	1542 (235)	1435	38
N5	CA	1433 (159)	1455 (157)	1461 (247)	1438	
	MSA	1402 (219)	1458 (137)	1481 (197)	1447	9
N6	CA	1600 (298)	1614 (250)	1612 (233)	1600	
	MSA	1579 (254)	1600 (137)	1624 (127)	1601	1
N7	CA	1395 (287)	1459 (202)	1492 (158)	1395	
	MSA	1427 (316)	1492 (182)	1553 (215)	1490	95
N8	CA	1484 (254)	1577 (173)	1482 (241)	1484	
	MSA	1424 (383)	1587 (174)	1555 (196)	1522	38
N9	CA	1543 (320)	1618 (151)	1677 (221)	1543	
	MSA	1556 (367)	1673 (250)	1701 (274)	1643	100

Table (12): PP measurements of the non-experts

Spr	Style	Onset	Mid	Offset	Mean	Diff
N1	CA	1038 (102)	1099 (94)	1008 (97)	1048	
	MSA	1058 (138)	1129 (96)	1120 (71)	1102	54
N2	CA	1252 (155)	1226 (118)	1209 (145)	1229	
	MSA	1282 (160)	1268 (136)	1258 (170)	1269	40
N3	CA	984 (292)	1041 (188)	1045 (102)	1023	
	MSA	1113 (199)	1140 (142)	1076 (136)	1109	86
N4	CA	1100 (122)	1162 (87)	1140 (86)	1134	
	MSA	1101 (101)	1189 (48)	1191 (55)	1160	26
N5	CA	888 (83)	986 (94)	989 (79)	954	
	MSA	927 (98)	979 (91)	953 (118)	953	1
N6	CA	1057 (212)	1089 (142)	1075 (141)	1073	
	MSA	995 (93)	1039 (137)	1075 (156)	1036	+37
N7	CA	991 (69)	1086 (80)	1012 (74)	1029	
	MSA	1010 (68)	1082 (74)	1054 (90)	1048	19
N8	CA	964 (71)	1075 (52)	1023 (76)	1020	
	MSA	875 (321)	1121 (60)	1085 (78)	1033	7
N9	CA	990 (96)	1075 (129)	1036 (104)	1033	
	MSA	1158 (96)	1247 (155)	1175 (96)	1193	160

Table (13): EE measurements of the non-experts


1750
1600
1450
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F2 frequency (Hz)
onset
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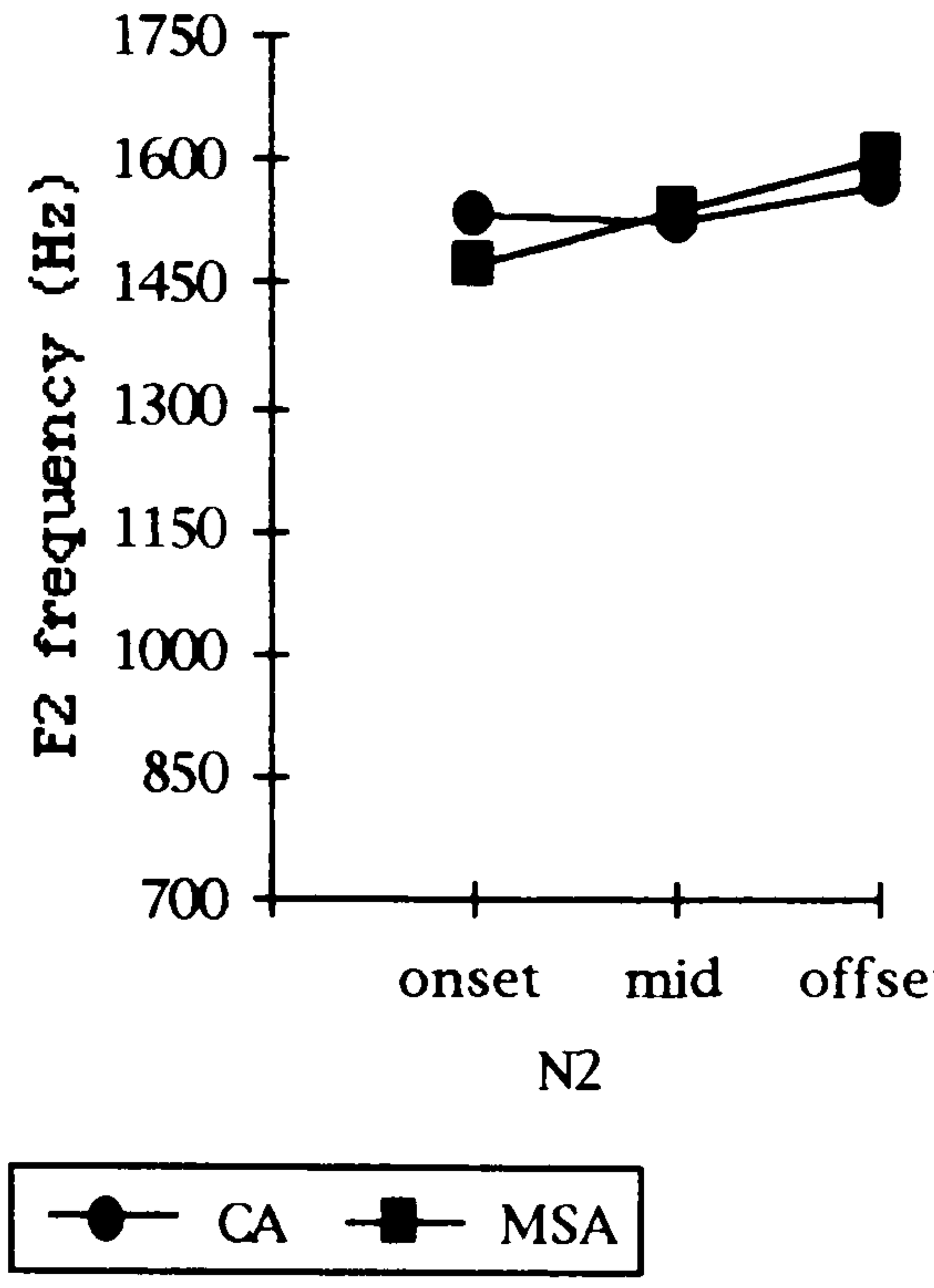
N1
CA
MSA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F2 frequency (Hz)
onset
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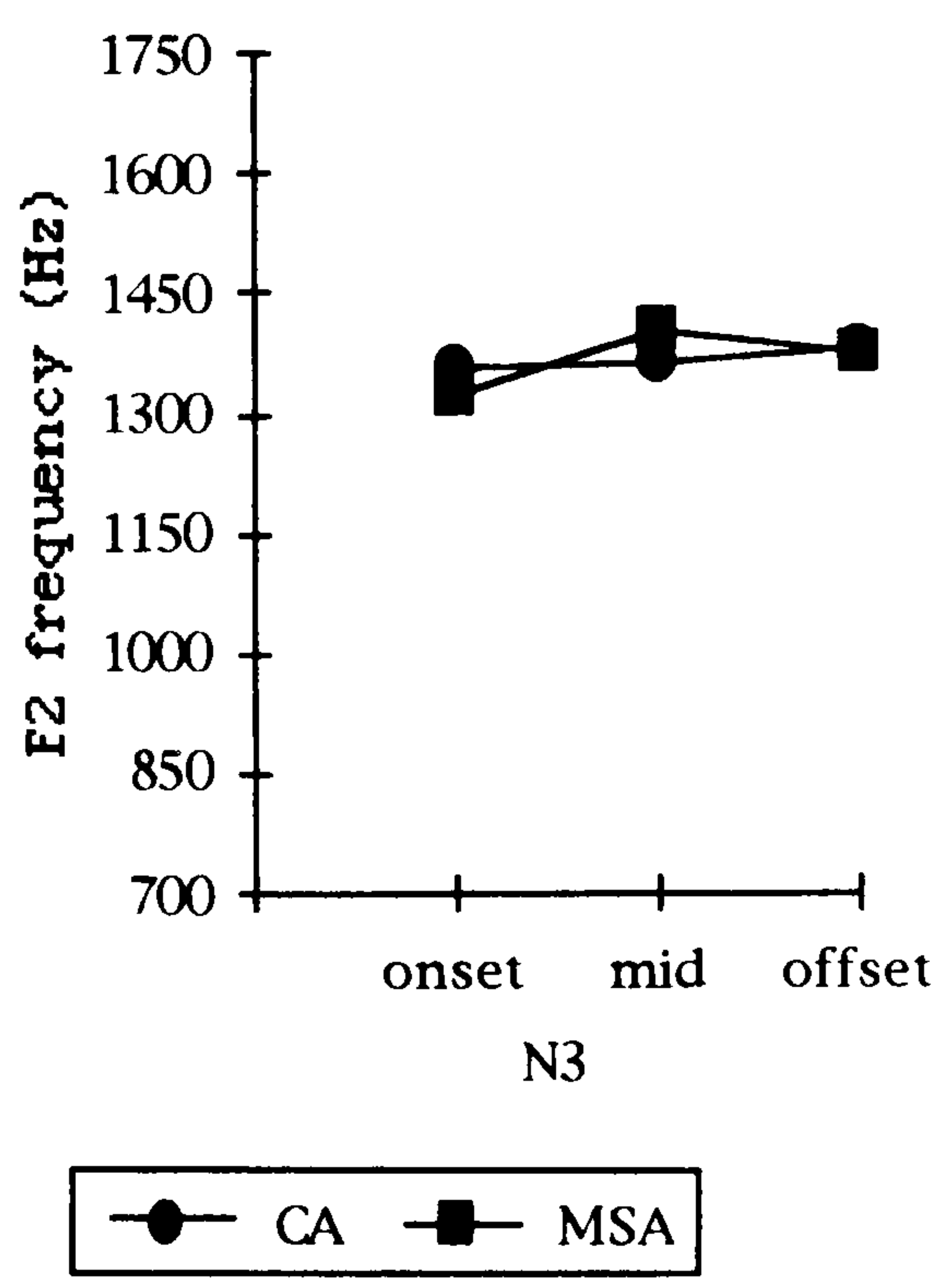
N2
CA
MSA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F2 frequency (Hz)
onset
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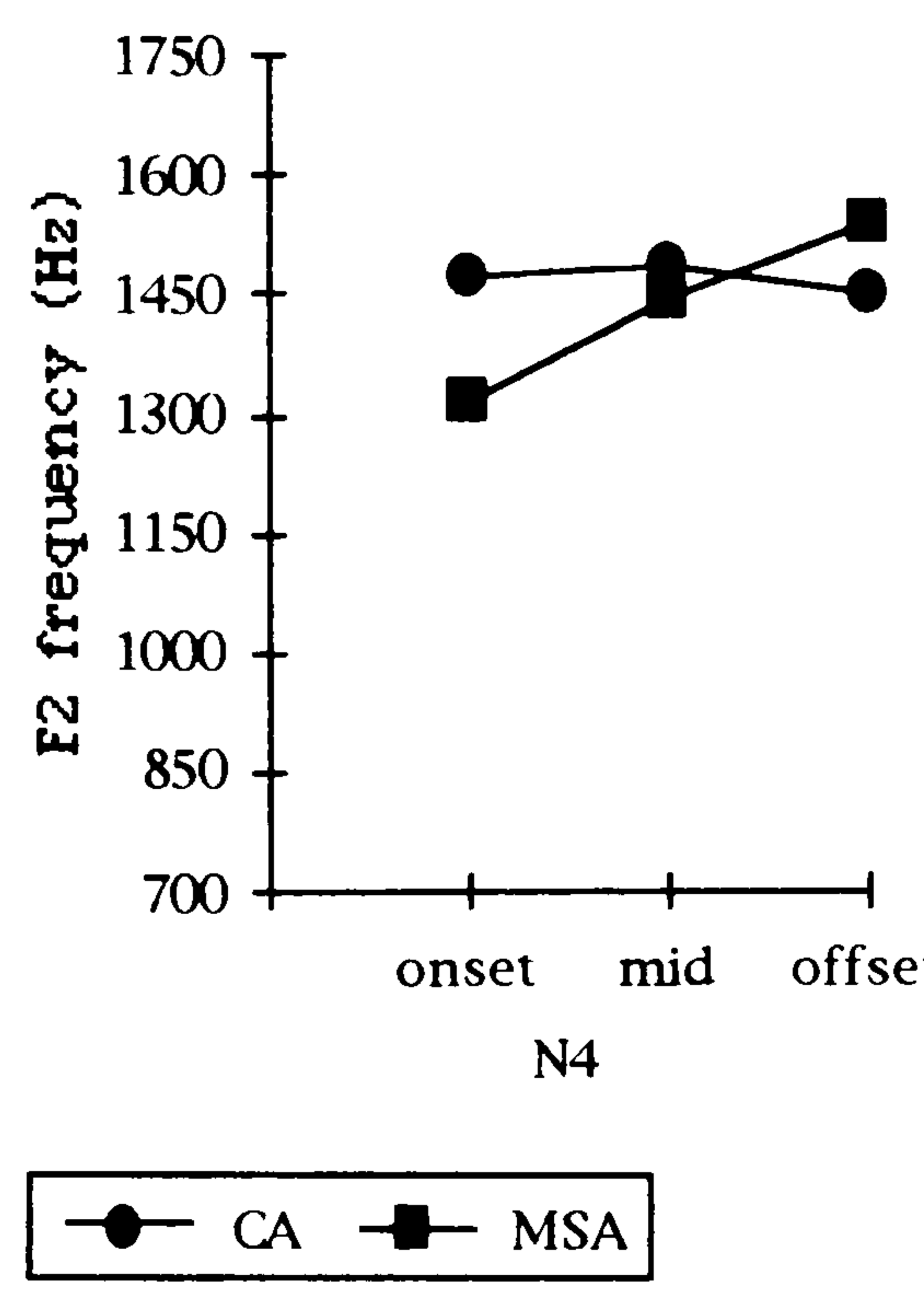
N3
CA
MSA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F2 frequency (Hz)
onset
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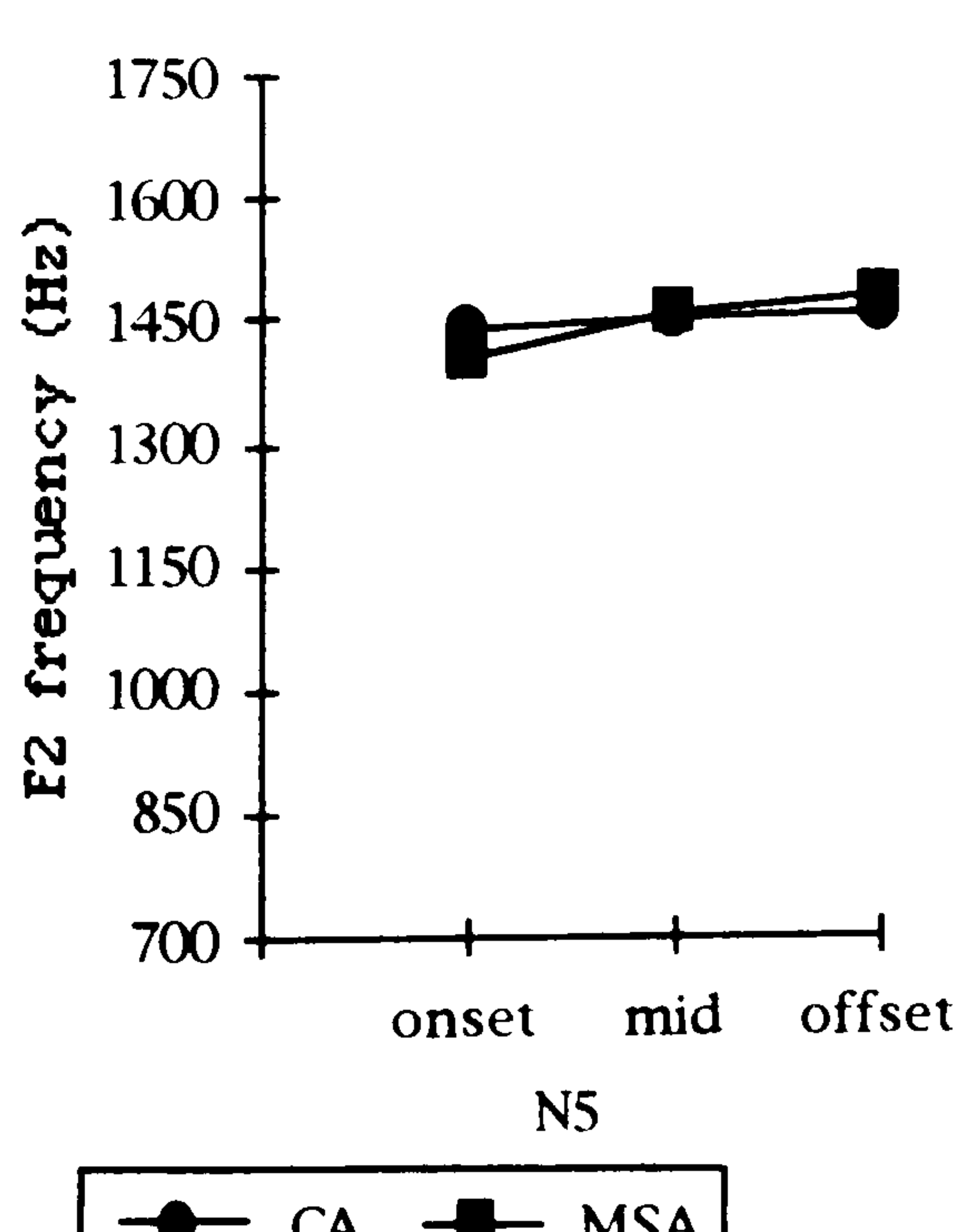
offset
N4
CA
MSA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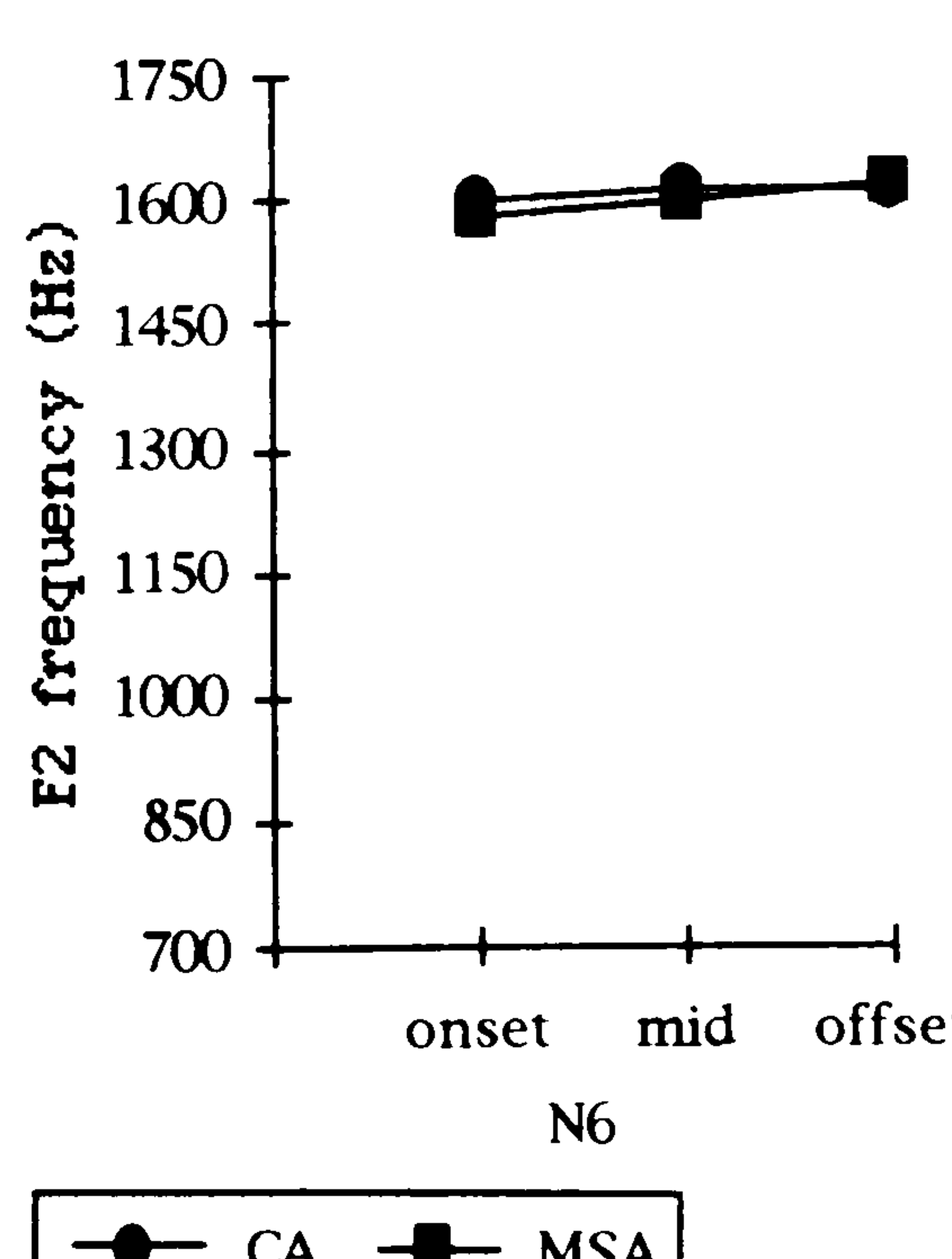
F2 frequency (Hz)
onset
mid
offset
N5
CA
MSA


1750
1600
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700
F2 frequency (Hz)
onset
mid
offset
N6
CA
MSA

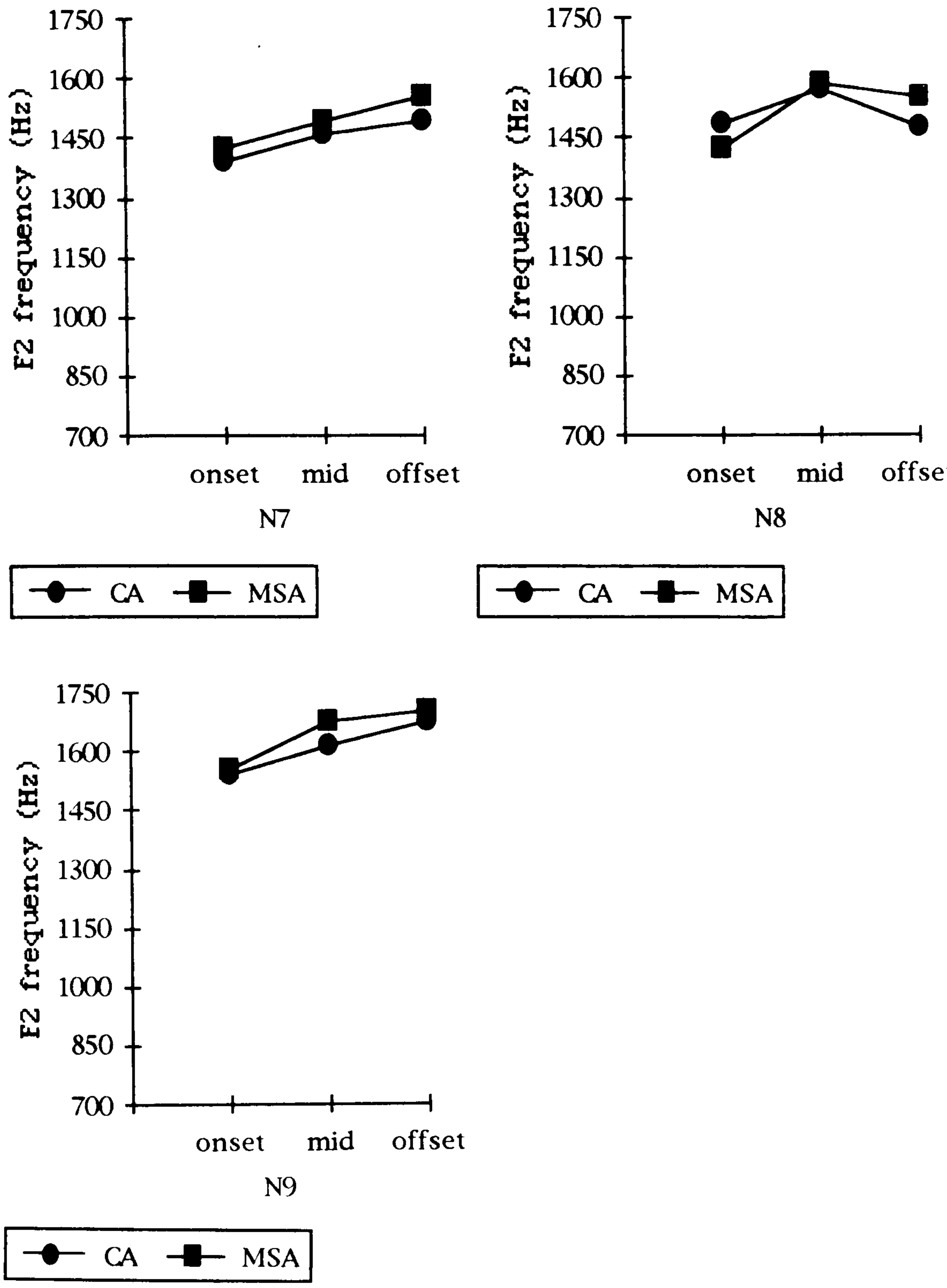
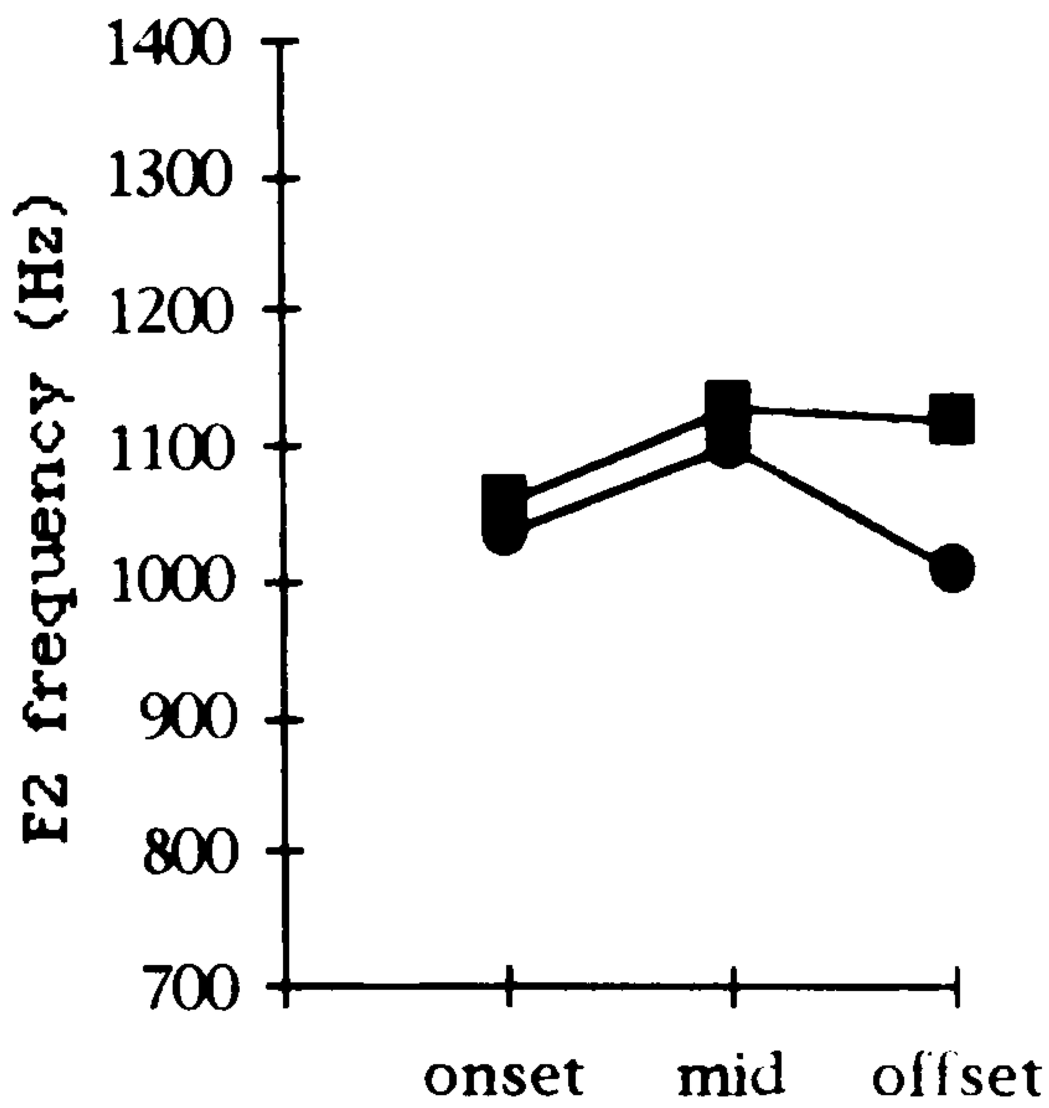
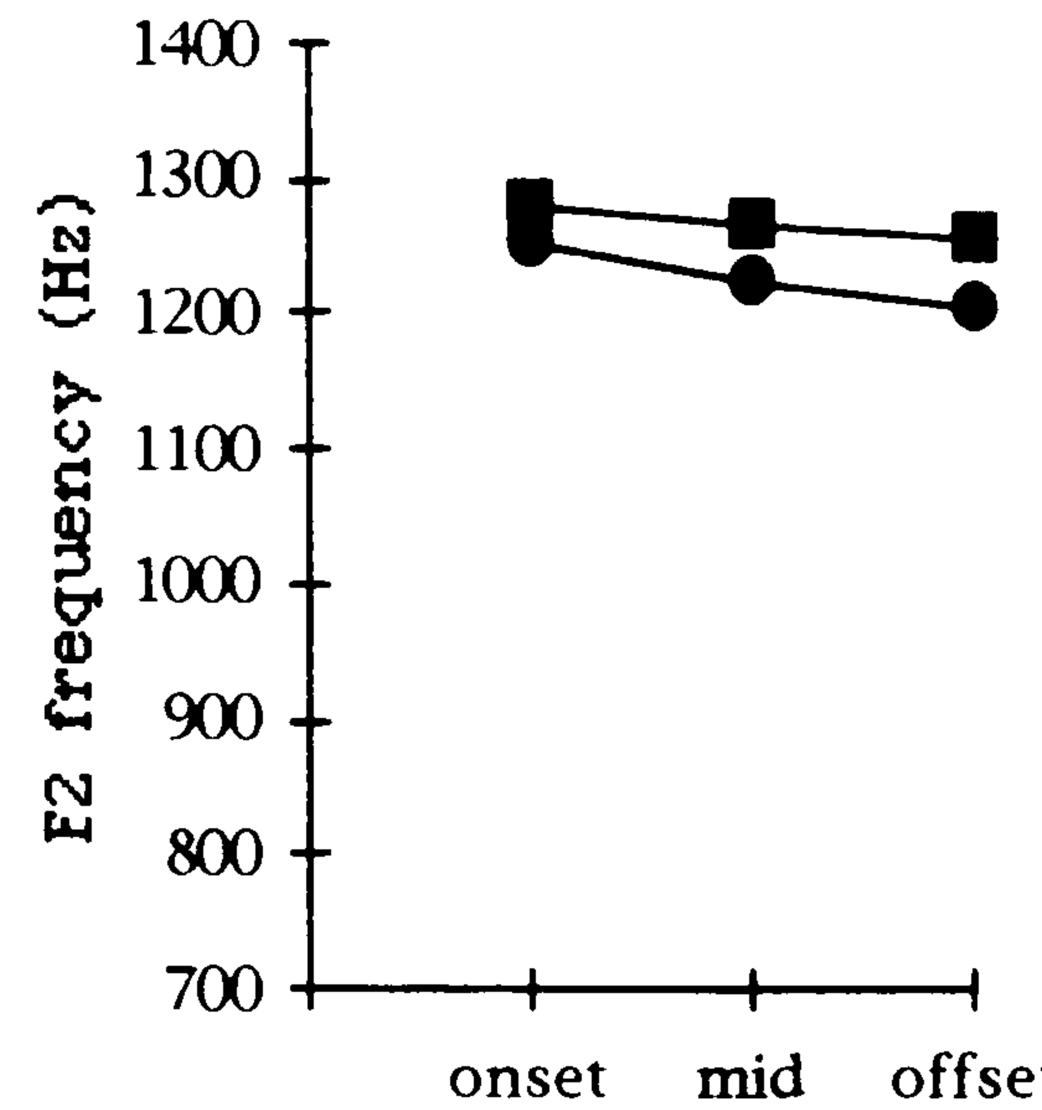


Fig. (30): PP trajectories of the non-experts



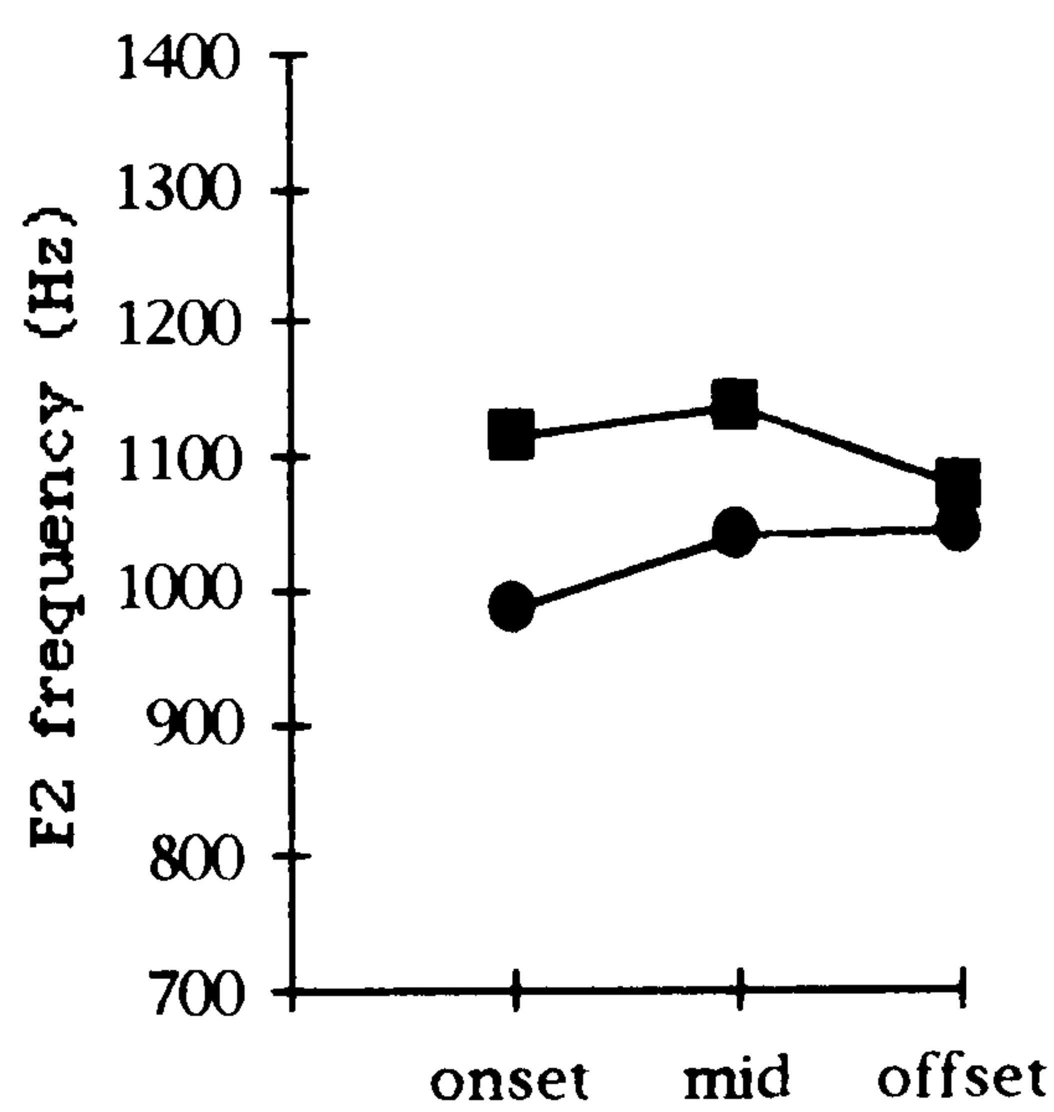
N1

CA MSA



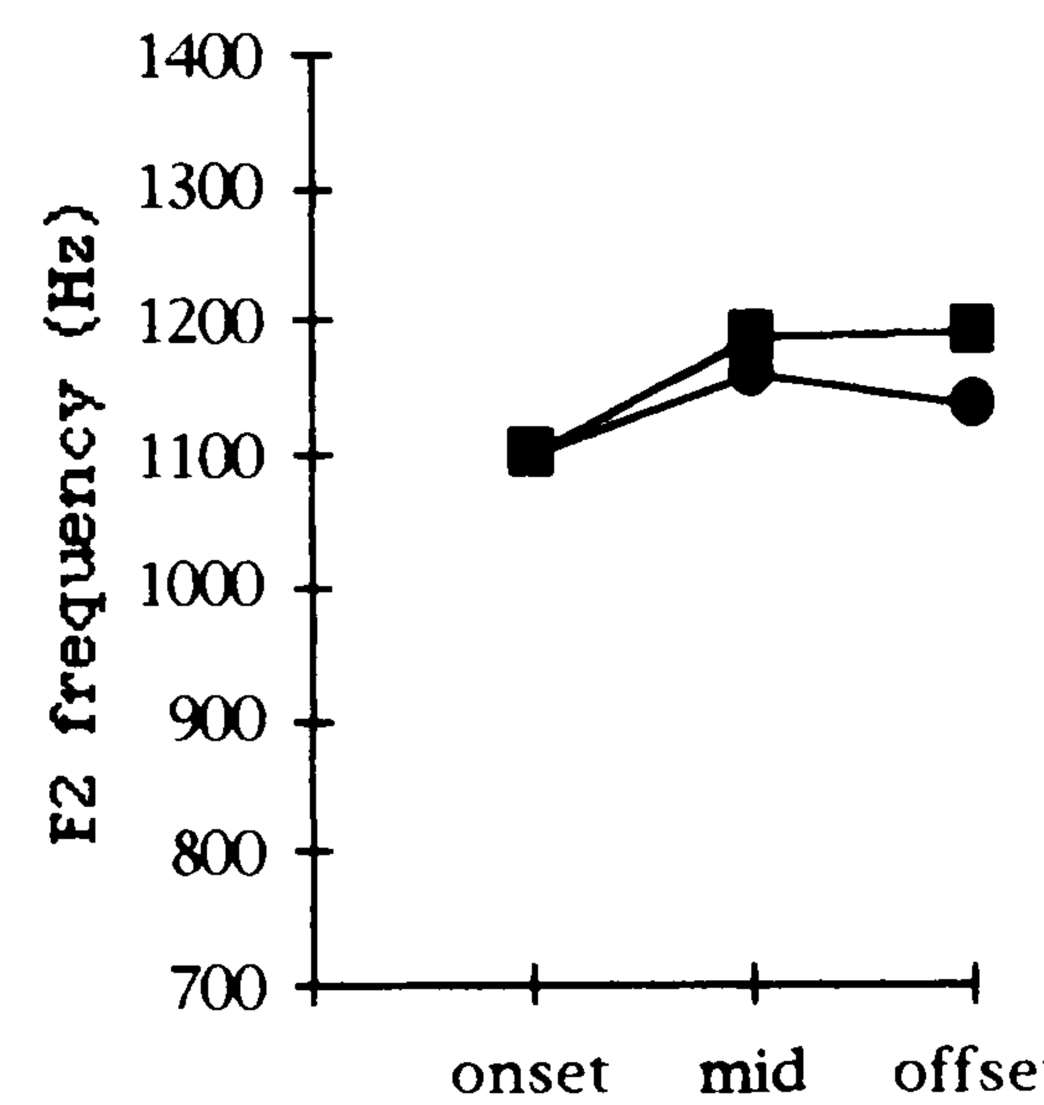
N2

CA MSA



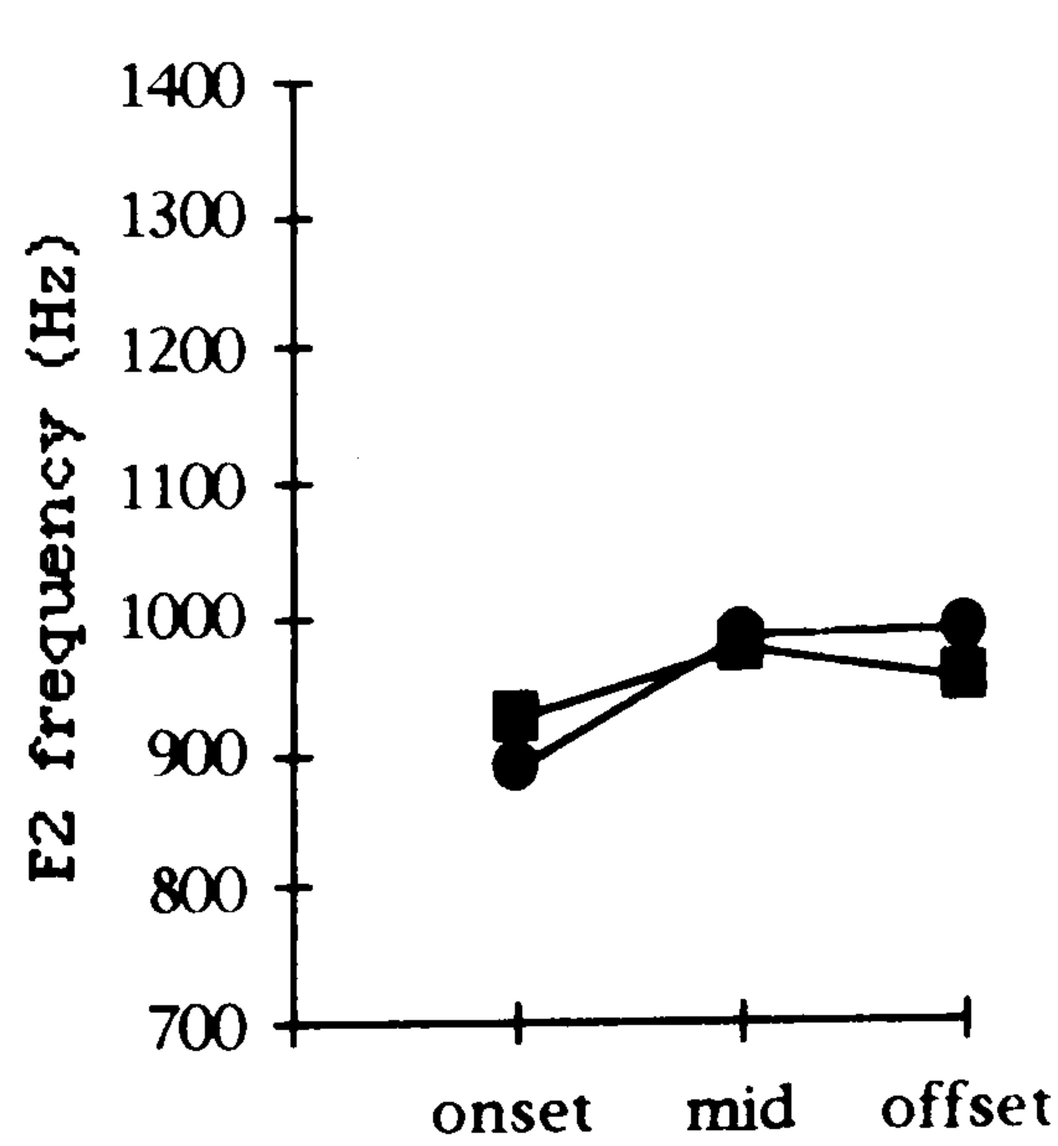
N3

CA MSA



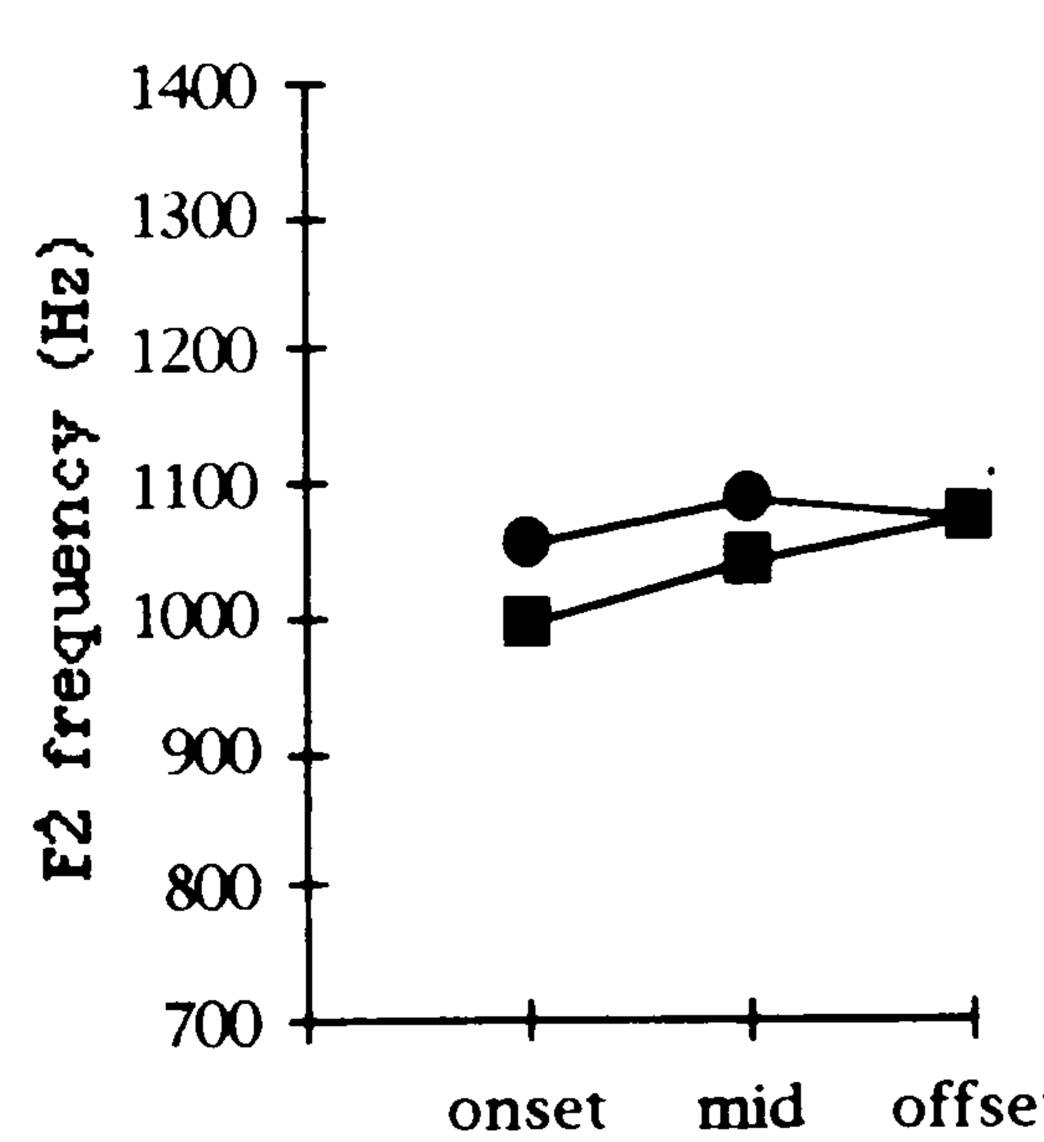
N4

CA MSA



N5

CA MSA



N6

CA MSA

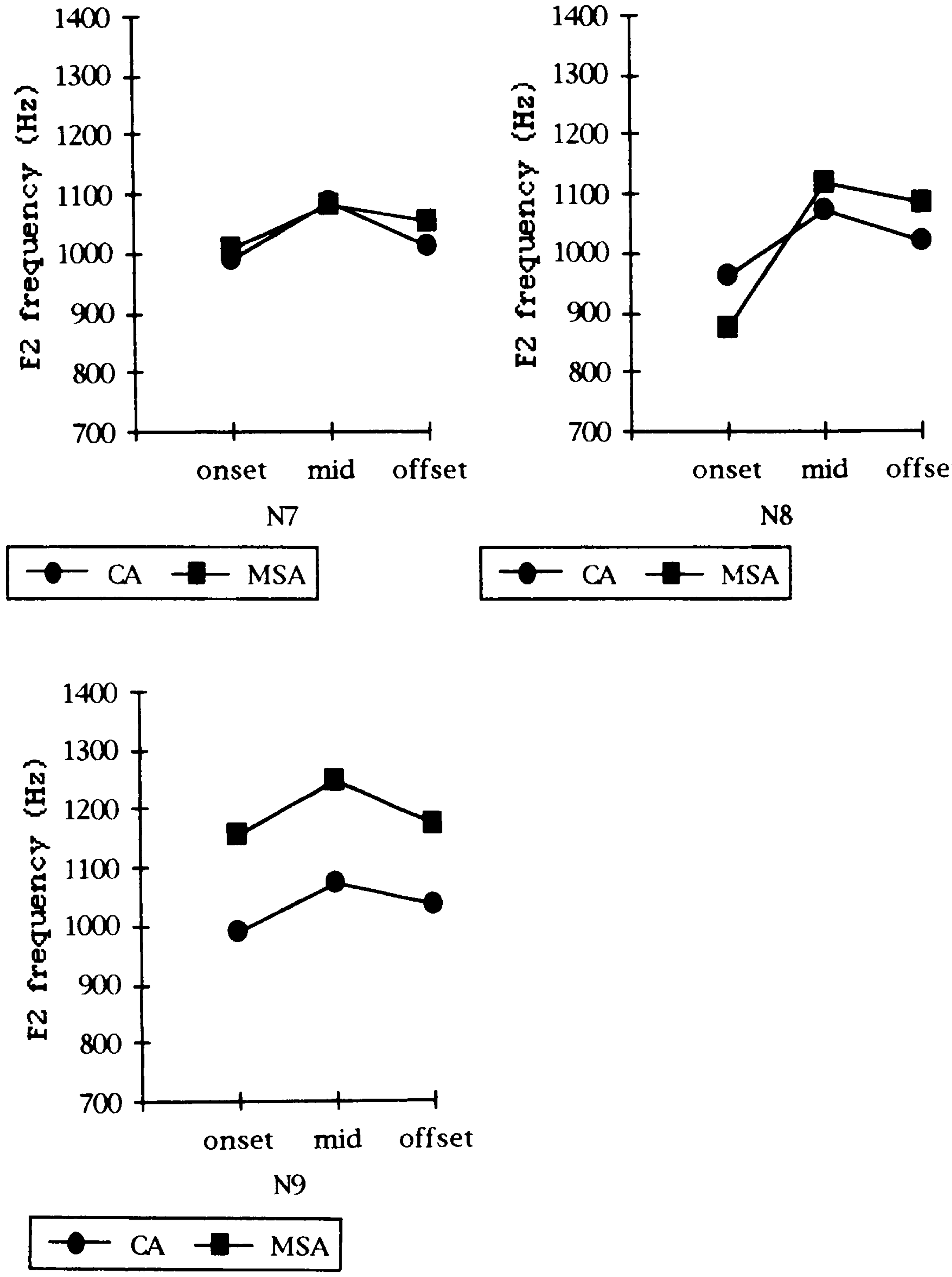


Fig. (31): EE trajectories of the non-experts

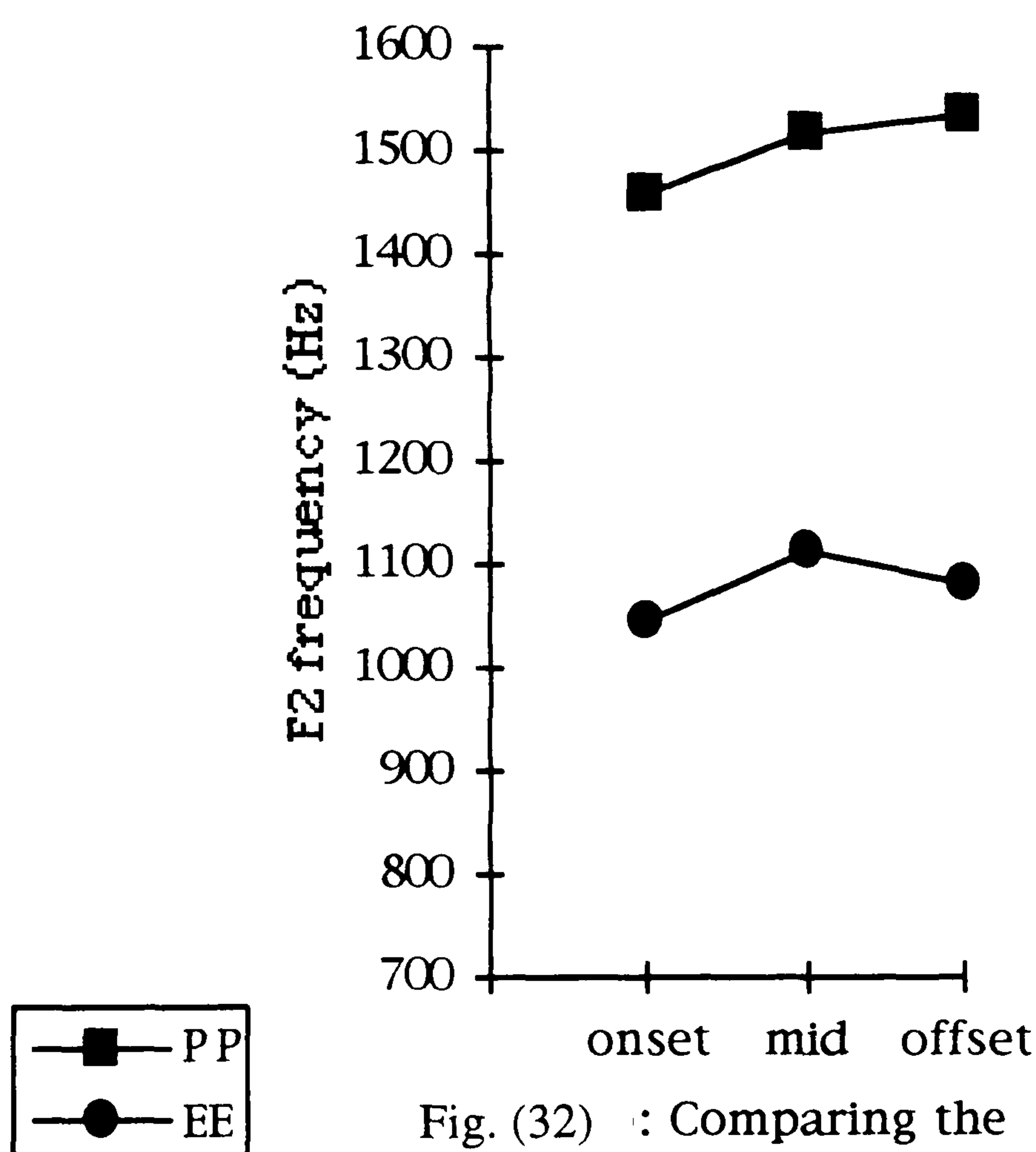


Fig. (32) : Comparing the PP/EE trajectories of the non-experts plainness. Note that the peak in the midpoint, which we attributed to non-linguistic factors (see section 4.2.2.2 above), still characterizes the EE trajectories.

The contrast between CA and MSA is only clear with the EE context. However, it seems that N9 - who is a special case as was indicated earlier - induces a larger emphatic gesture for CA than his colleagues because his EE trajectory is lower for this style. On the other hand, other speakers (e.g. N2, N4, N5 and N7) do not apparently distinguish between CA and MSA. The implication of that could be that the two styles do not show differences in a completely plain environment, unlike in a completely emphatic environment. It could also mean that some non-experts do not treat CA and MSA as different styles.

Speaker, style and context were used as independent variables and the mean value of the vowel's onset, midpoint and offset as dependent variable. ANOVA showed no significant main effect for speaker and style in the PP context and there was no significant interaction between the two variables. On the other hand, ANOVA showed a significant main effect for speaker ($F(5,84) = 12.13$ $p < .001$) in the EE context, while the difference between styles was found non-significant. There was also no significant interaction between speaker and style. This could imply that the non-experts had different reading abilities and that is, indeed, consistent with their ratings (see section 4.2.5 below). It also shows that the speakers did not make the clear contrast between CA and MSA that we saw with the experts.

4.2.3.3 EP/PE contexts

The mean onset, mid and offset values for each speaker are presented in Tables (14) and (15) along with ΔF2 values. Figures (33) and (34) show the trajectories of the speakers. In the EP context, CA sometimes has a larger ΔF2 than MSA because the speakers induce a larger emphatic gesture in the vowel in recitation. We assume that some speakers retain a lower onset for this style (e.g. N3, N6 and N9) and that some others do not. In other words, not all of them make a clear distinction between the two styles. In the PE context, CA shows a larger ΔF2 than MSA. Some speakers exhibit a sharp elbow for CA while others do not. But it was stated before that we could neither quantify the elbows nor decide what they exactly refer to. Only two speakers (N6 and N7) exhibit a higher onset and lower offset for CA and retain a high midpoint in this context. Some speakers exhibit similar trajectories for both CA and MSA while others appear to differentiate them.

Fig. (35) expresses the overall difference between the non-experts' EP and PE trajectories (based on the mean values of the speakers' measurements). The trajectories cross at the midpoints of the vowels and the spaces between the onsets and offsets are almost the same. Indeed, the PE trajectory may be regarded as the mirror image of the EP trajectory.

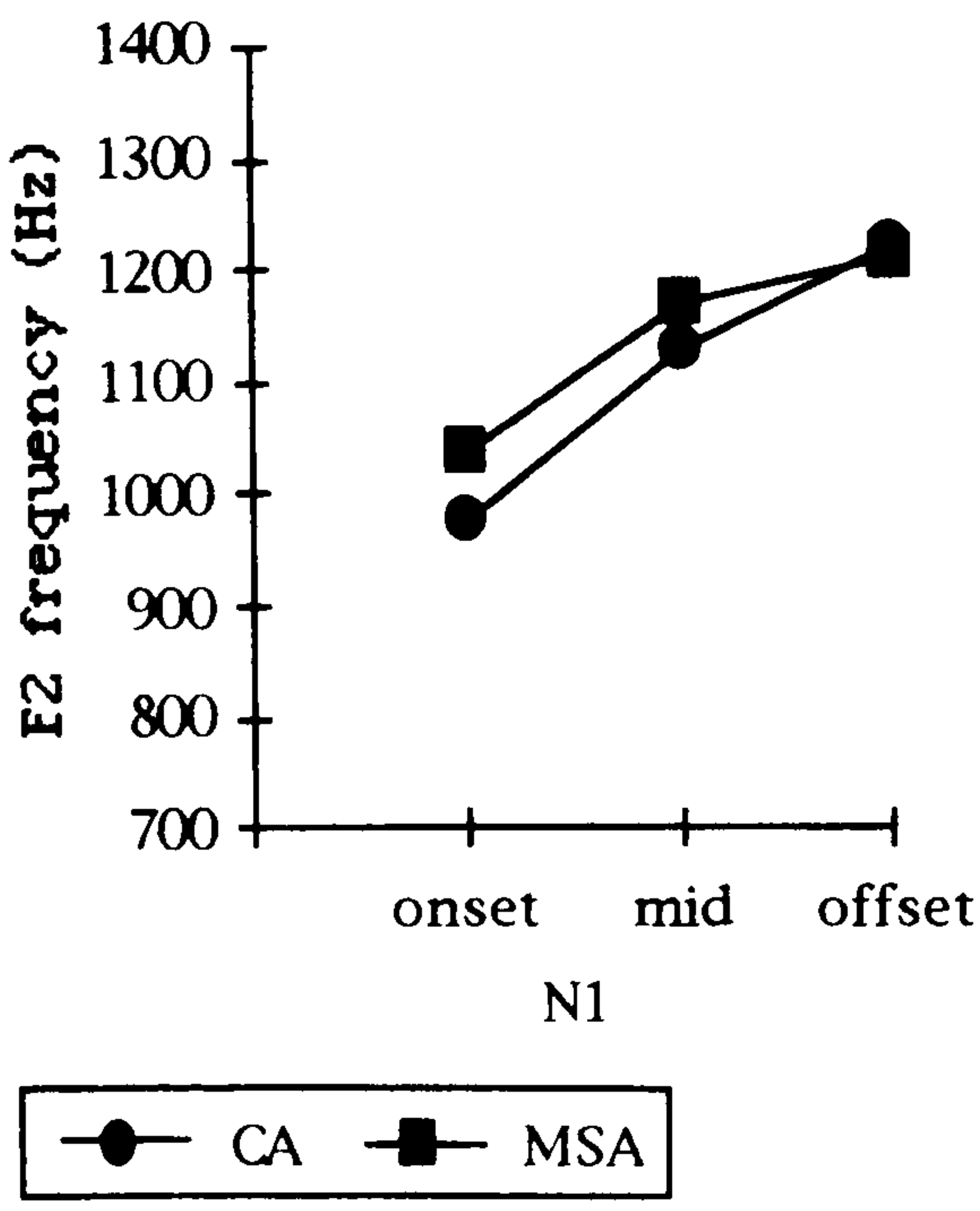
As we did with the experts, we will quantify the asymmetry values of the non-experts which are indicated in Table (16), computed by the formula adopted in section 4.2.2.3 above. Speakers N5, N6, N7 and N8 are closer to +1 than their colleagues who could have a strong bias towards emphatic anticipatory assimilation. In other words, the PE/EP trajectories of the poor non-expert reciters cross over the midpoints of the

Spr	Style	Onset	Mid	Offset	ΔF2	ΔF2 diff
N1	CA	975(224)	1127(149)	1220(300)	245	
	MSA	1035(169)	1172(193)	1211(343)	176	69
N2	CA	1170(193)	1253(119)	1276(196)	106	
	MSA	1212(221)	1287(194)	1267(308)	55	51
N3	CA	987(188)	1062(177)	1197(293)	210	
	MSA	1126(156)	1176(172)	1212(319)	86	124
N4	CA	1130(214)	1202(217)	1224(269)	94	
	MSA	1091(229)	1256(224)	1212(365)	121	27
N5	CA	917(223)	1023(129)	1168(253)	251	
	MSA	942(187)	1065(192)	1124(336)	336	69
N6	CA	955(194)	1136(183)	1318(310)	363	
	MSA	1029(225)	1229(198)	1326(322)	297	66
N7	CA	972(52)	1134(95)	1338(186)	366	
	MSA	986(97)	1101(44)	1239(235)	271	95
N8	CA	990(96)	1128(91)	1259(210)	269	
	MSA	1023(167)	1173(163)	1242(247)	219	50
N9	CA	984(84)	1151(142)	1341(305)	375	
	MSA	1135(157)	1274(196)	1311(327)	176	181

Table (14): EP measurements of the non-experts

Spr	Style	Onset	Mid	Offset	Δ F2	Δ F2 Diff
N1	CA	1188(191)	1163(79)	1000(97)	188	
	MSA	1166(94)	1093(114)	975(137)	141	47
N2	CA	1210(141)	1221(82)	1169(170)	41	
	MSA	1205(105)	1216(128)	1167(185)	38	3
N3	CA	1076(199)	1025(56)	953(96)	123	
	MSA	1081(126)	1030(148)	1060(182)	21	102
N4	CA	1142(138)	1149(62)	1044(137)	98	
	MSA	1126(79)	1136(63)	1039(134)	87	11
N5	CA	1256(158)	1210(108)	1023(168)	233	
	MSA	1067(185)	1078(81)	1022(140)	45	188
N6	CA	1447(127)	1323(165)	1038(158)	409	
	MSA	1281(153)	1238(127)	1104(150)	177	232
N7	CA	1325(161)	1268(123)	968(144)	357	
	MSA	1258(217)	1186(102)	1029(117)	229	128
N8	CA	1374(211)	1327(156)	1073(112)	301	
	MSA	1145(185)	1166(77)	1072(108)	73	228
N9	CA	1317(147)	1161(89)	1030(76)	278	
	MSA	1268(180)	1217(139)	1169(84)	99	188

Table (15): PE measurements of the non-experts


1400
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E2 frequency (Hz)
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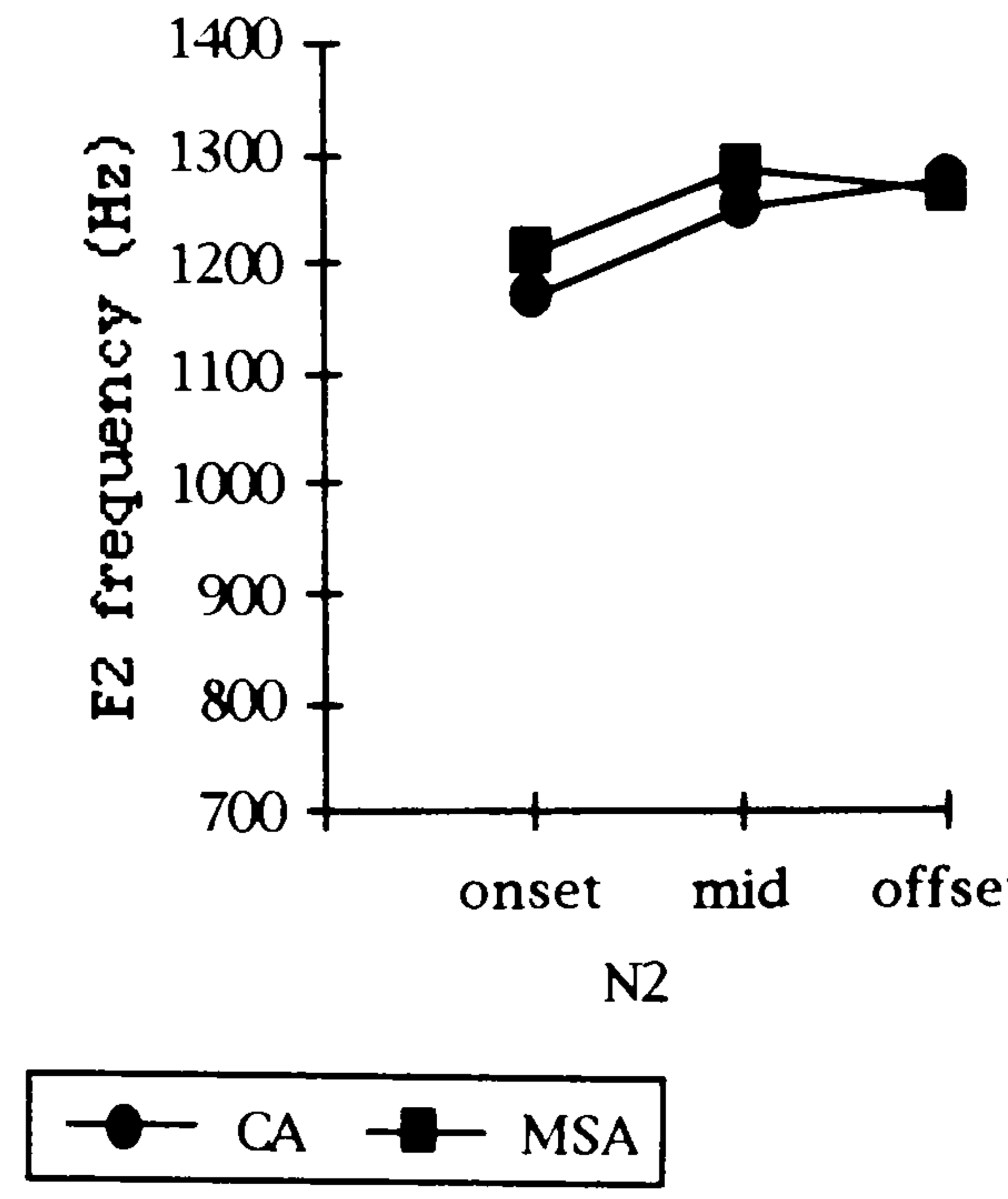
offset
N1
CA
MSA

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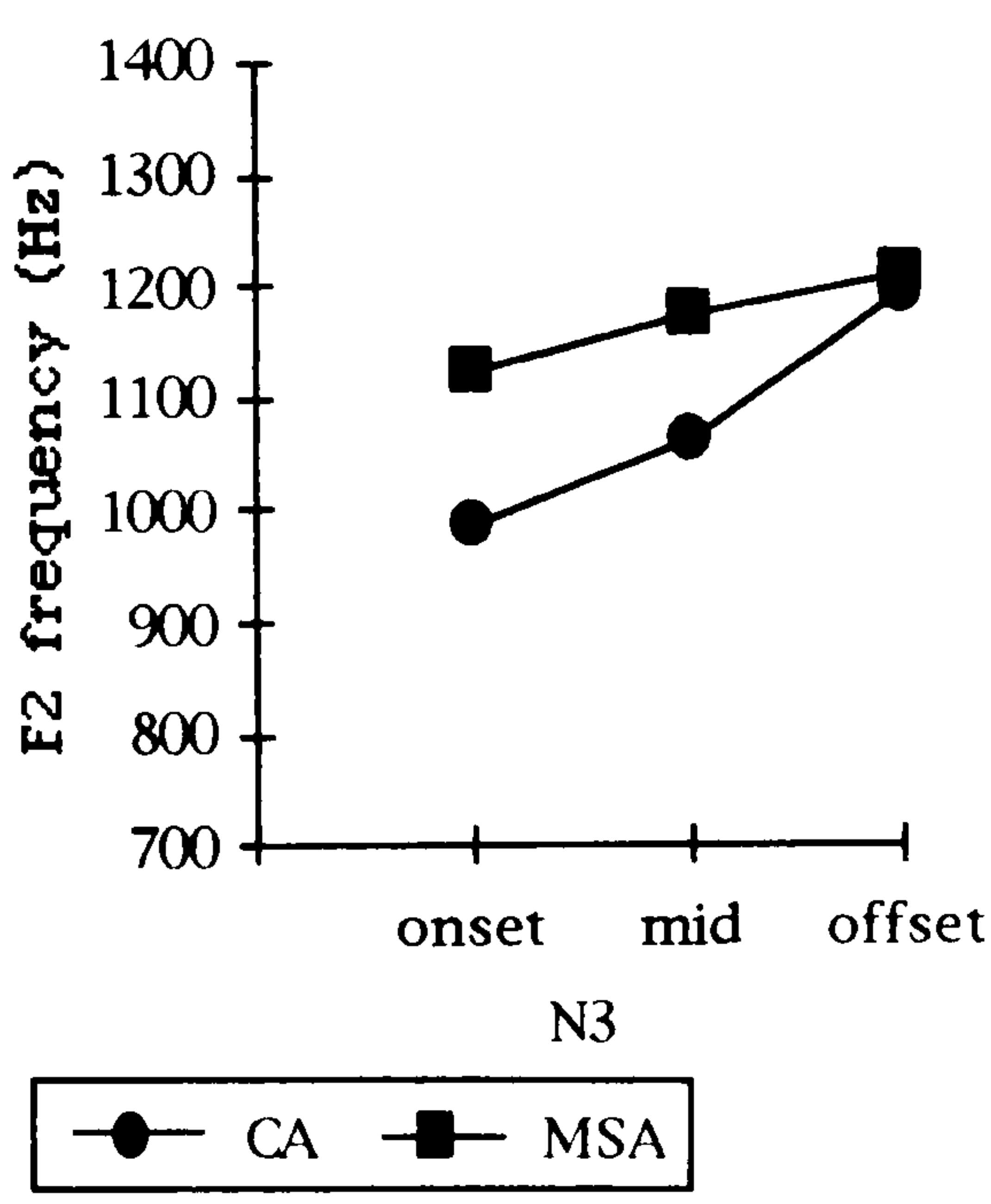
E2 frequency (Hz)
onset
mid
offset
N2
CA
MSA

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E2 frequency (Hz)
onset
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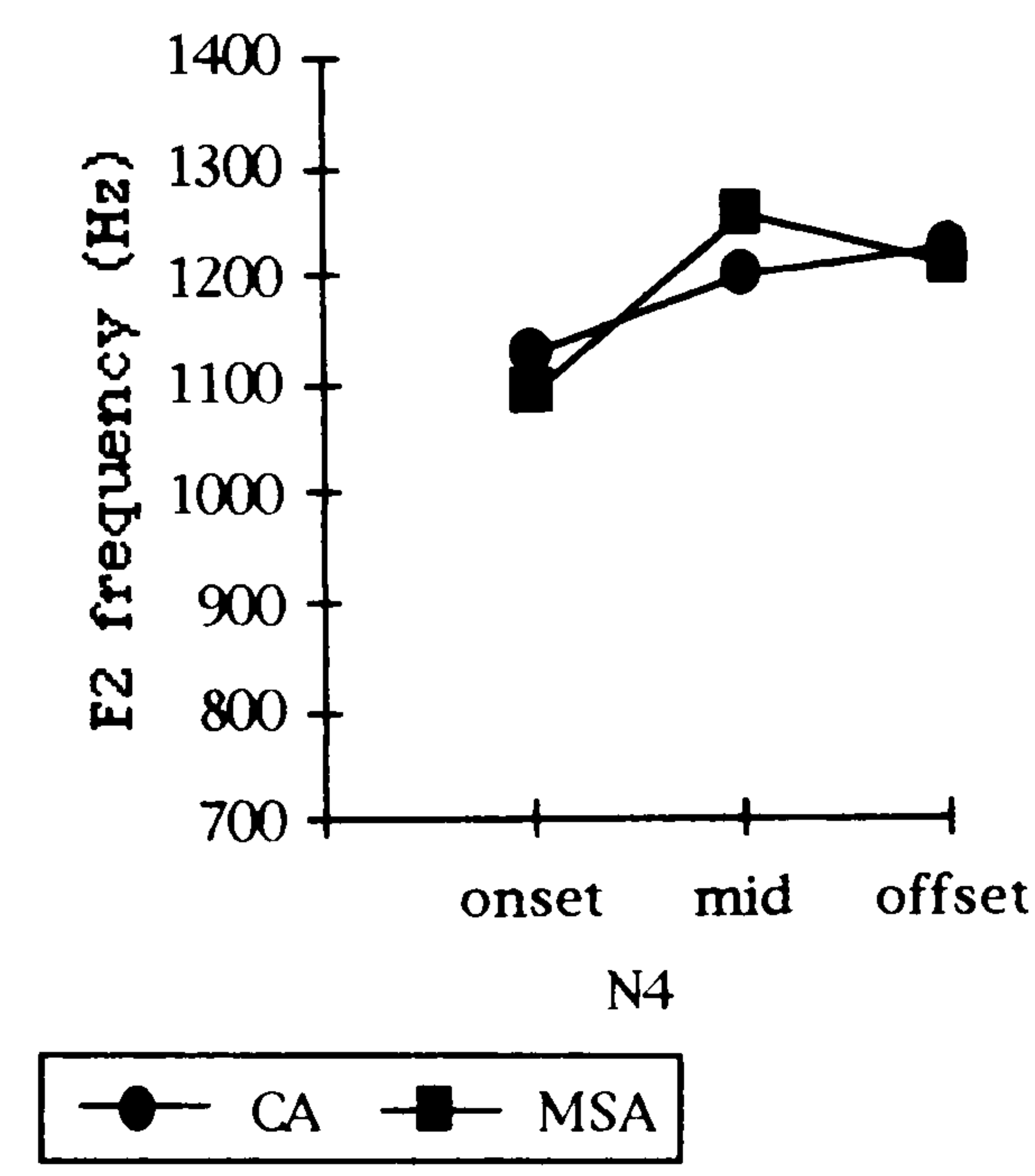
N3
CA
MSA

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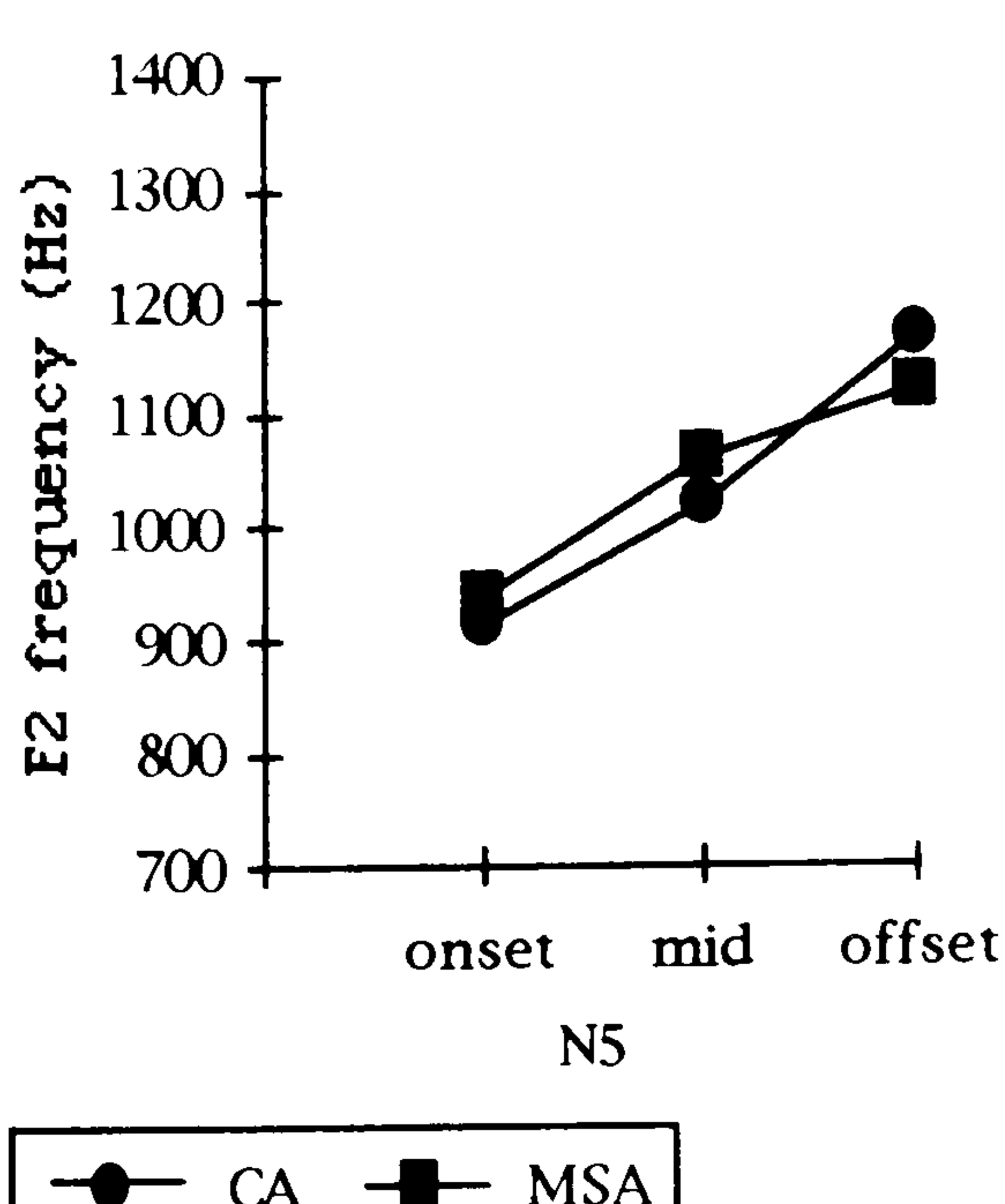
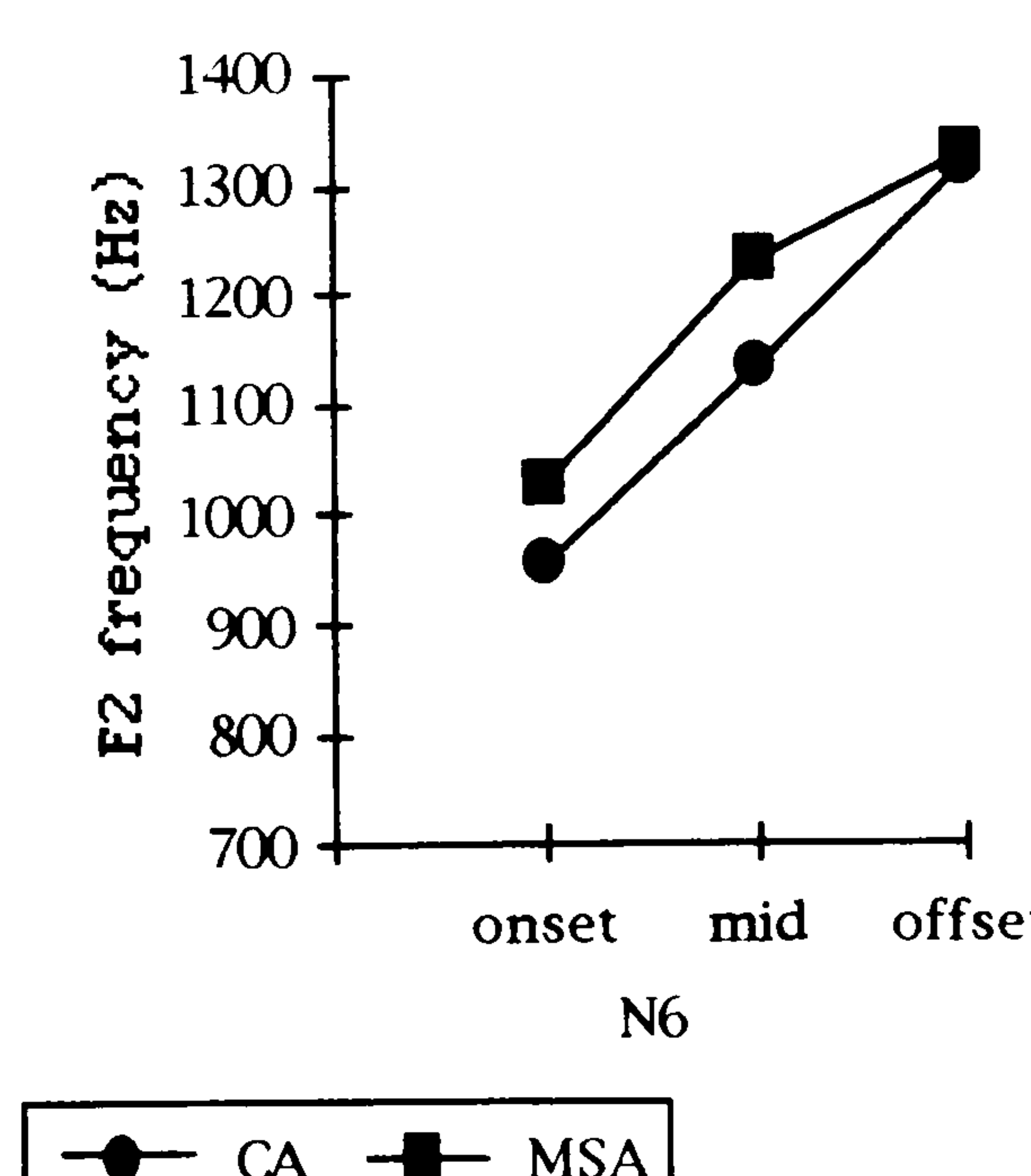
800
700
E2 frequency (Hz)
onset
mid
offset
N4
CA
MSA

1400
1300
1200
1100
1000
900
800
700
E2 frequency (Hz)
onset
mid
offset
N5
CA
MSA

1400
1300
1200
1100
1000
900
800
700
E2 frequency (Hz)
onset
mid
offset
N6
CA
MSA

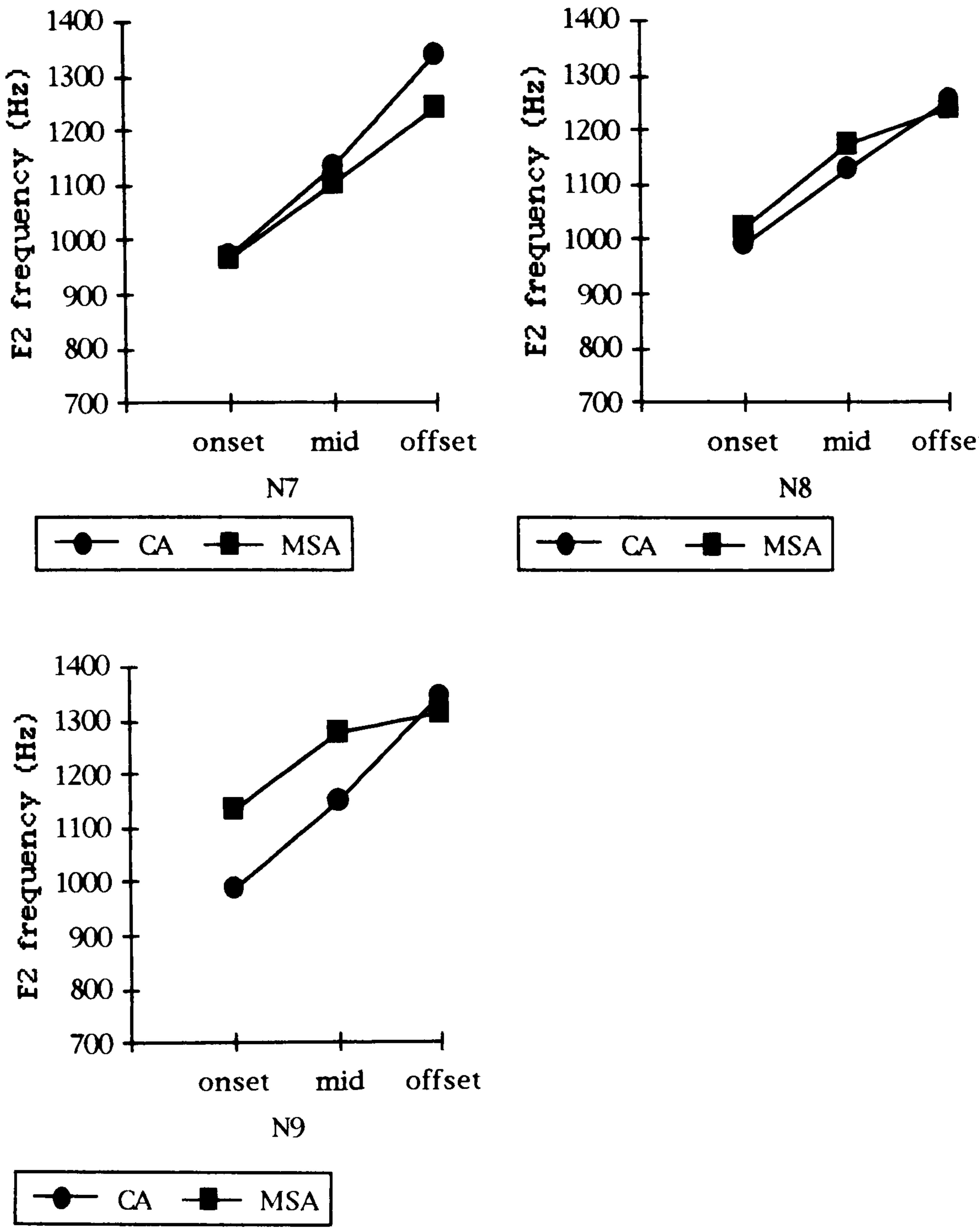
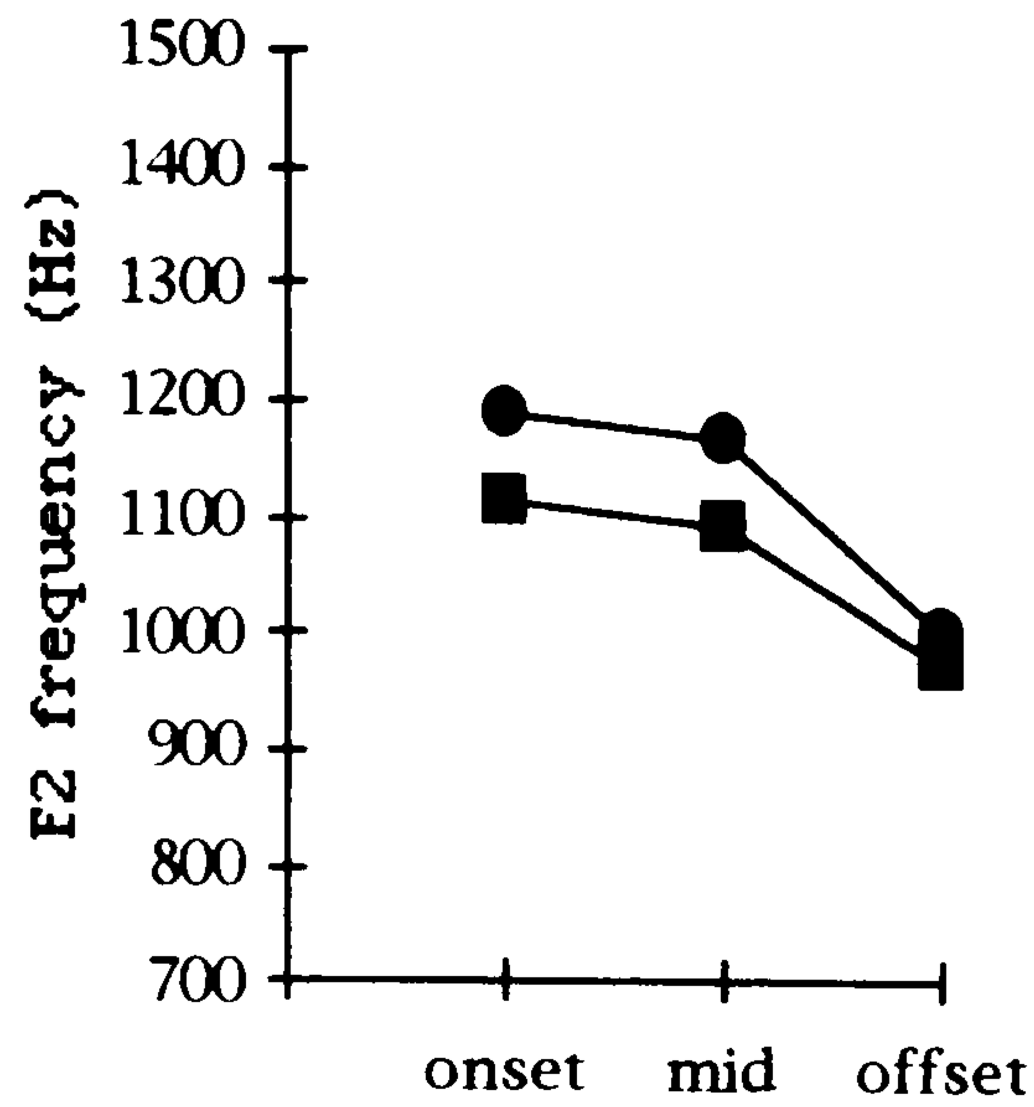
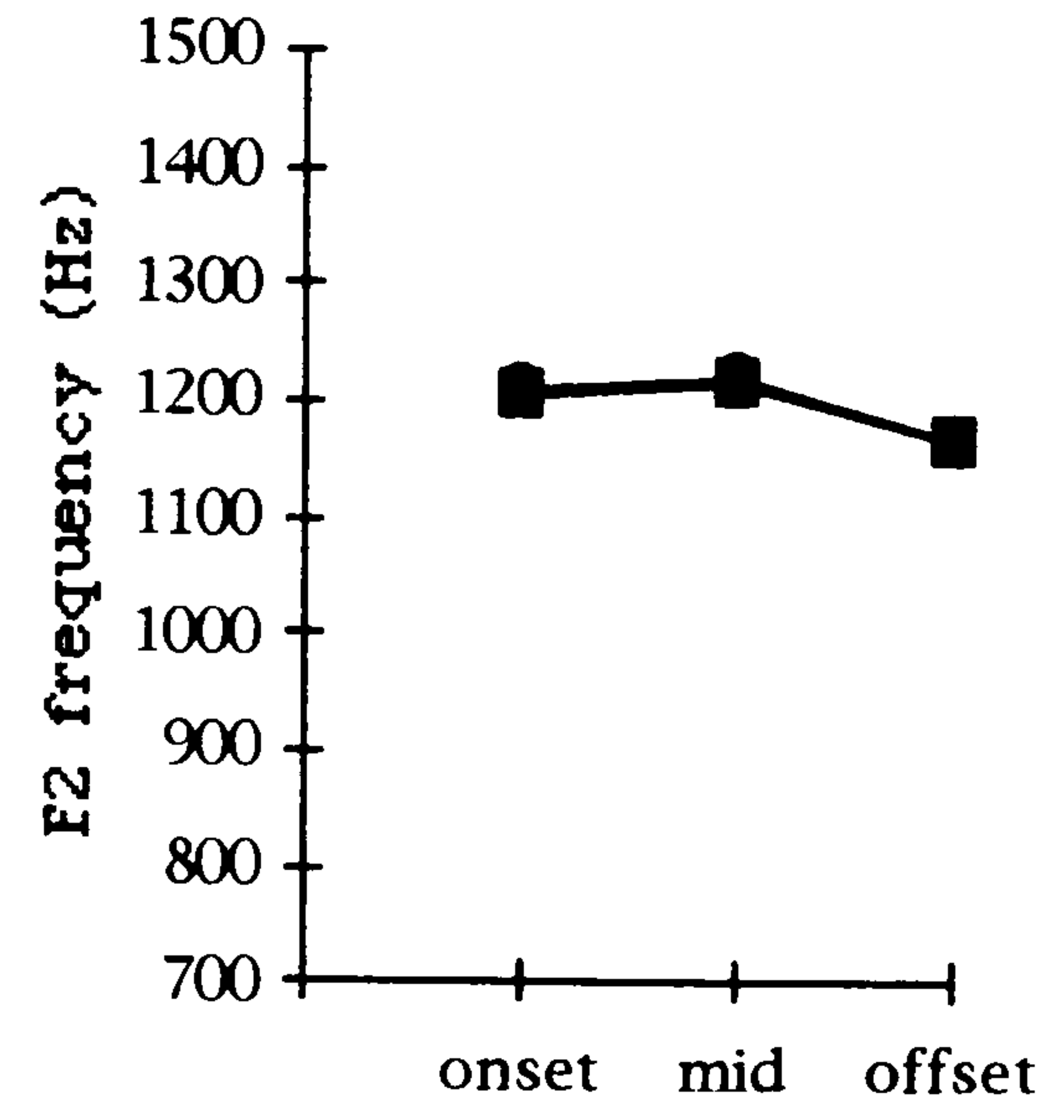


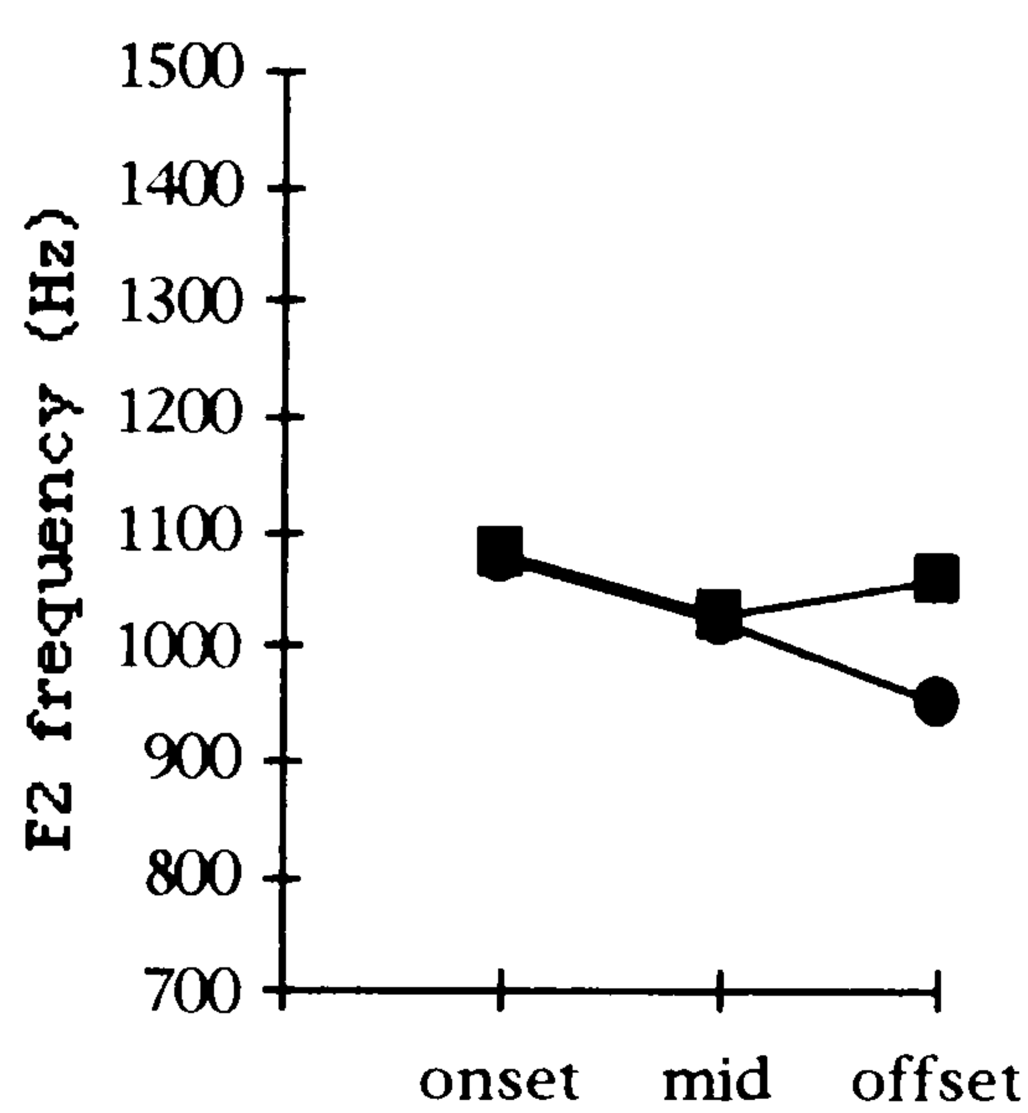
Fig. (33): EP trajectories of the non-experts



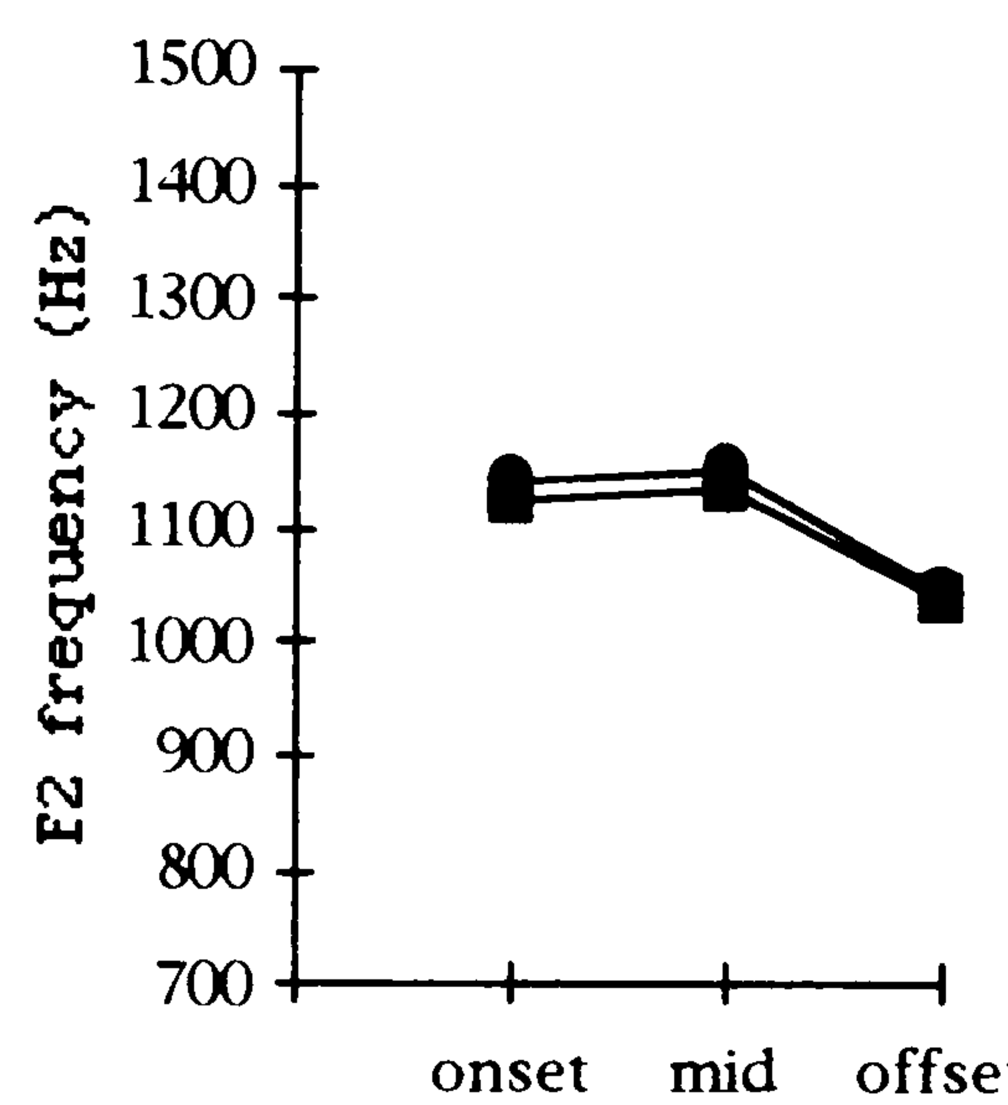
N1



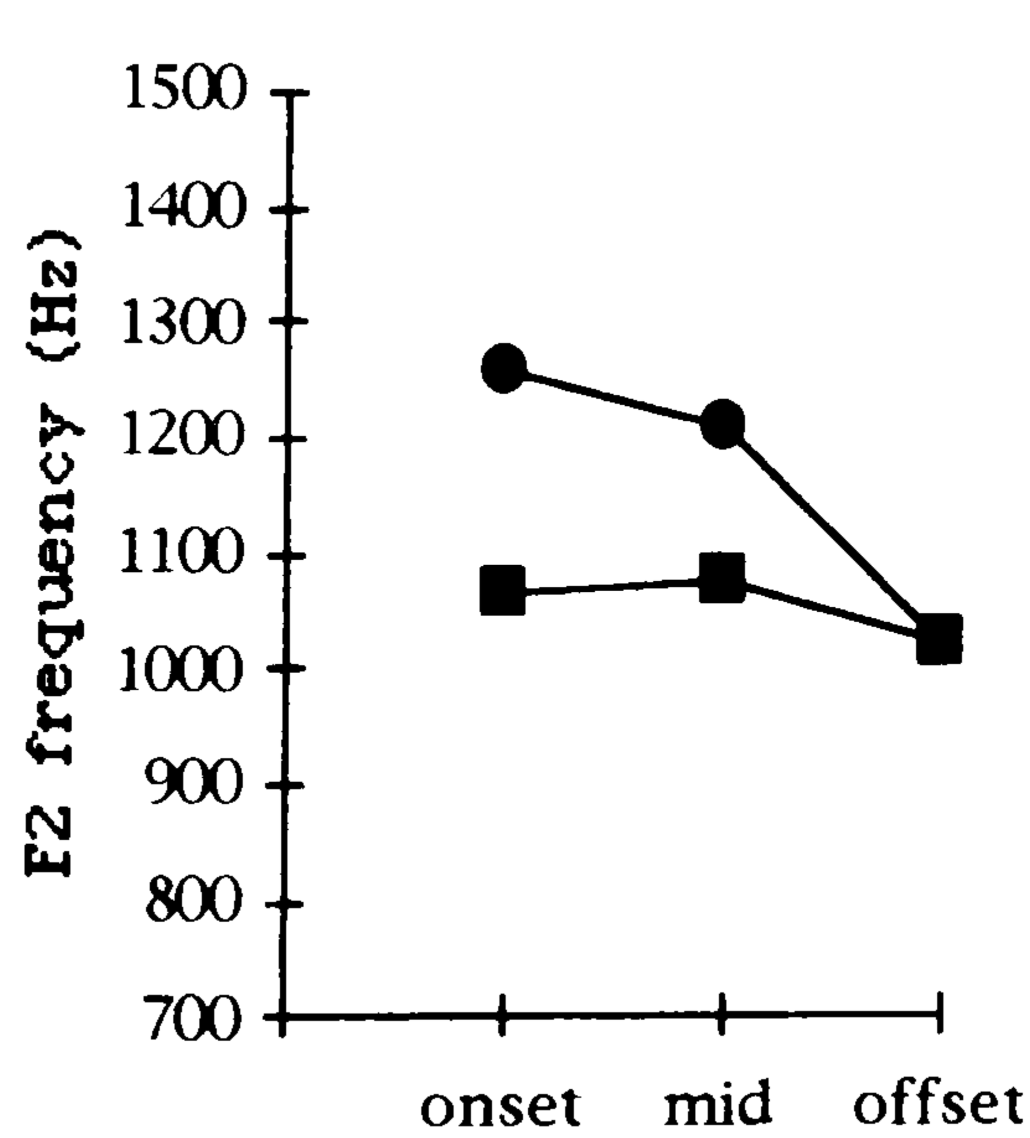
N2



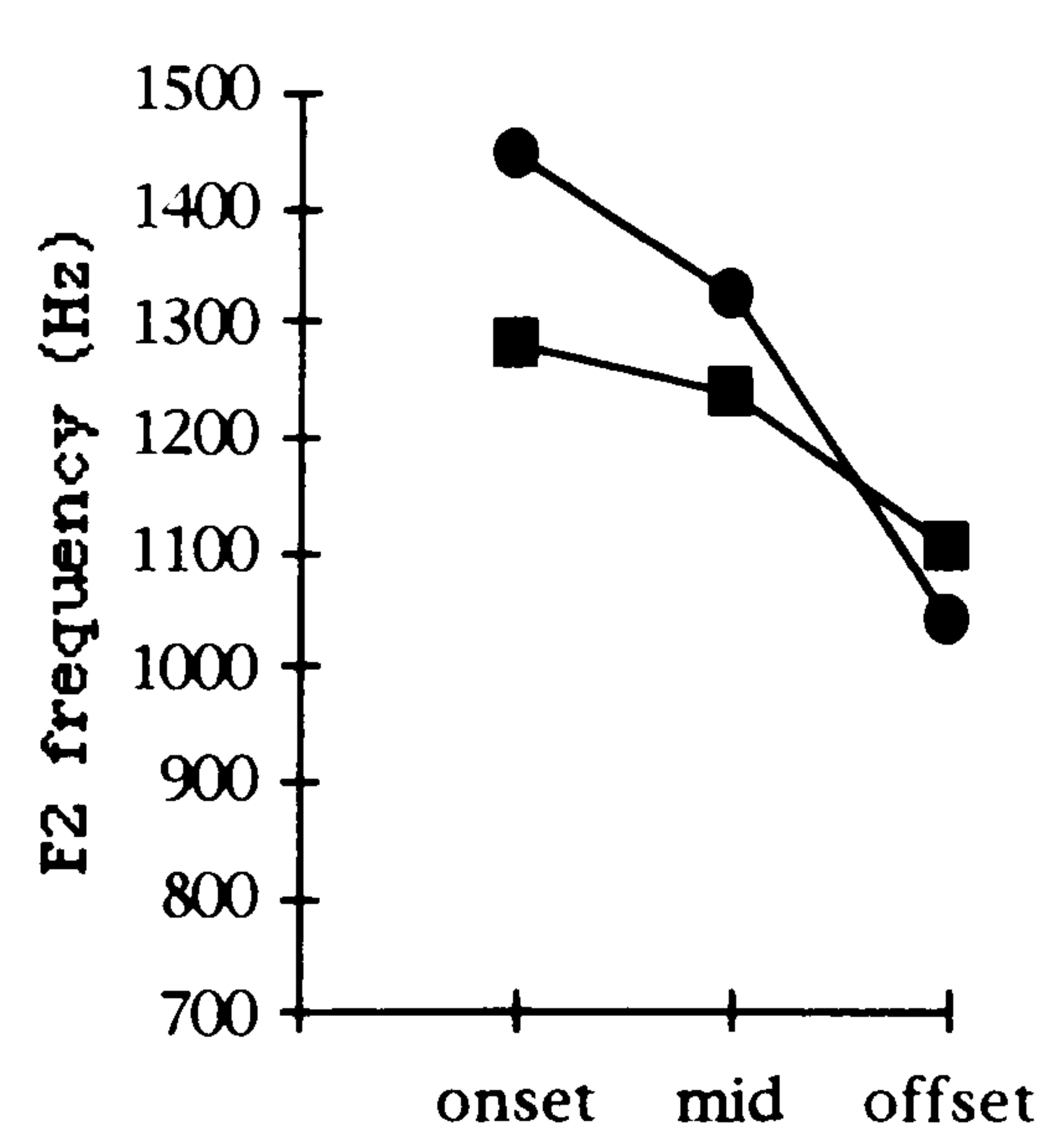
N3



N4



N5



N6

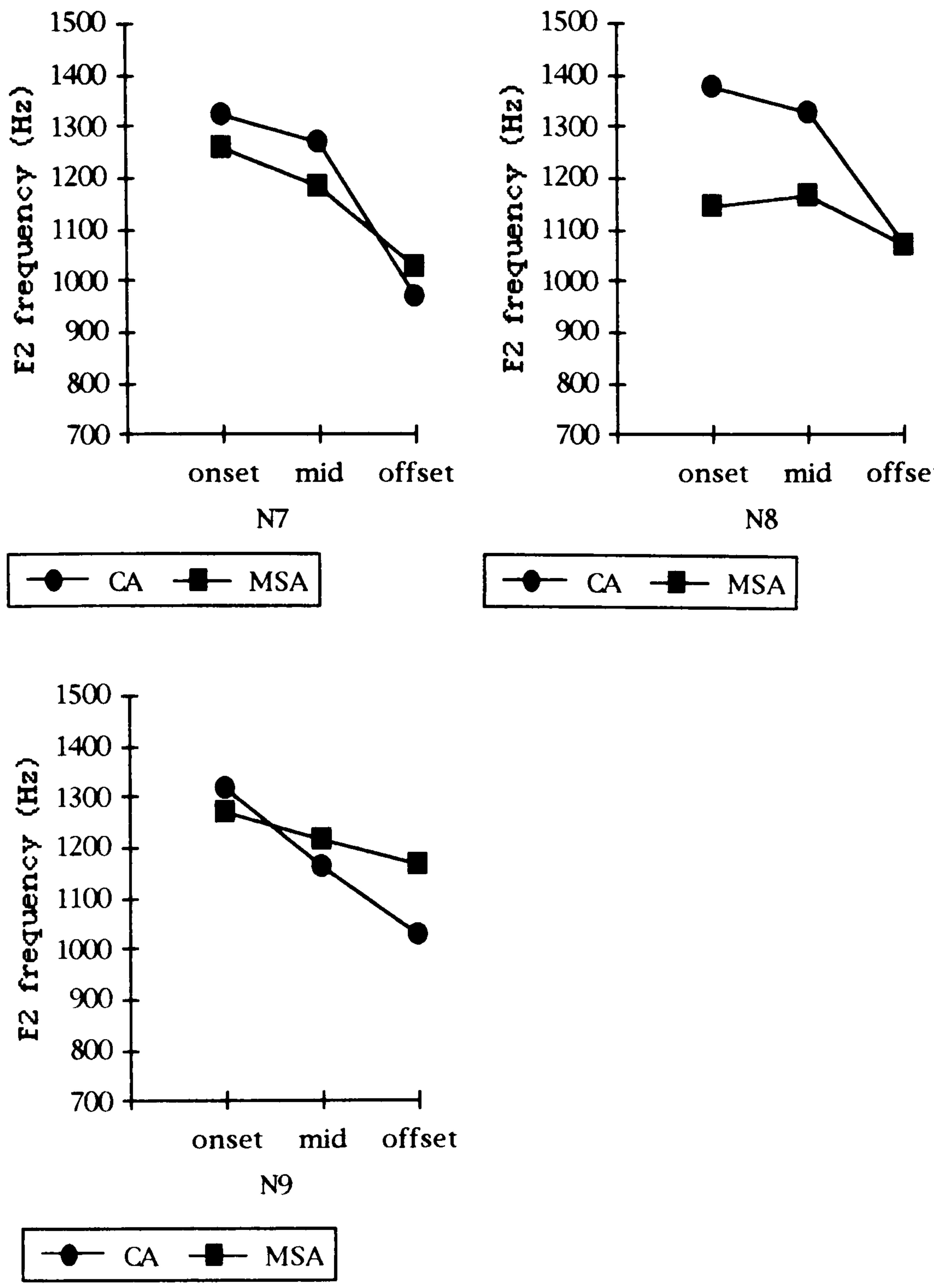


Fig. (34): PE trajectories of the non-experts

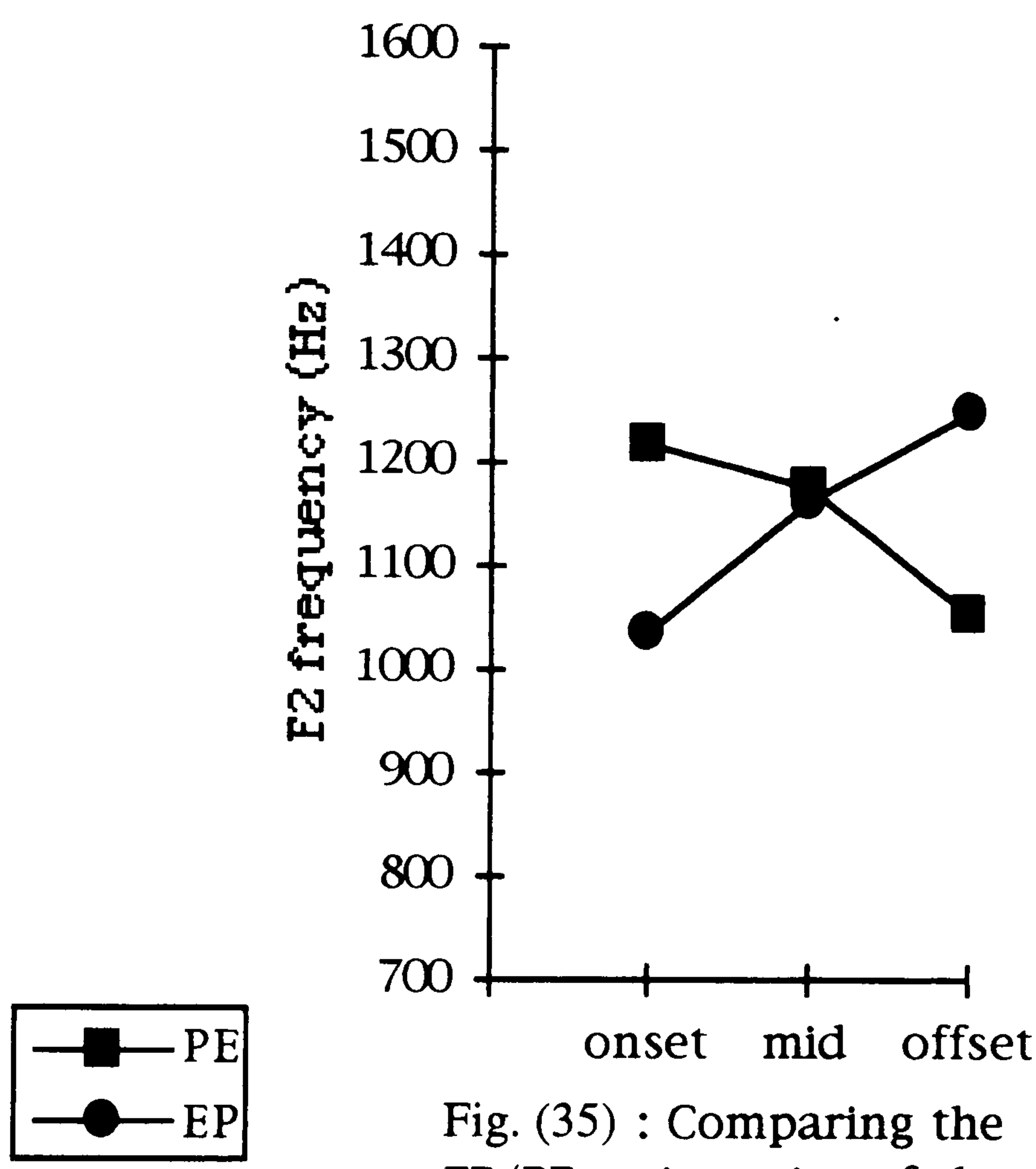


Fig. (35) : Comparing the EP/PE trajectories of the non-experts vowels. That would particularly apply to N1, N2, N3 and N4 who have low 'A' values below 0. It will be seen later in this chapter that these speakers were given low grades by the experts. Therefore, we expect there is some correlation between the values of the asymmetry and the non-experts' ratings. Unexpectedly, the EP/PE trajectories of N9 cross at the midpoints although his oral performance, according to the experts' ratings, was superior to that of his colleagues. Does that imply that he did not apply *tajwid* to the PE context or that the asymmetry

	A	
Speaker	CA	MSA
N1	0.17	-0.60
N2	-0.8	-87.
N3	-0.42	-191.
N4	-4.42	-3.43
N5	0.55	0.10
N6	0.38	0.28
N7	0.38	0.31
N8	0.52	-0.06
N9	0.03	0.08

Table (16): Values representing the asymmetry (non-experts)

was affected by non-linguistics factors such as the shape of his vocal tract? The answer to that is not yet clear. But he could remain to be treated as an exceptional case. Actually, that could give an indication that the elbow, which this speaker does not exhibit in his PE trajectory, is less important than other parameters such as $\Delta F2$.

Let us now consider the statistical results. Speaker, style and context were used as independent variables and $\Delta F2$ as dependent variable with the EP/PE contexts. ANOVA showed no significant main effect for speaker and style in the EP context and there was no significant interaction between the two variables. On the other hand, there was a significant main effect for speaker ($F(8,126) = 3.06$ $p < .01$) and style ($F(1,126) = 13.4$ $p < .001$) in the PE context, and there was no significant interaction between the two variables. Thus, the speakers' distinction between styles was only significant in the PE context, in cases where emphasis may be resisted by some speakers. Using 'A' as dependent variable, however, no significant main effect was found for speaker, and no significant interaction between speaker and style. That could mean that the speakers were more or less similar in their performances. But that explicitly contradicts the experts'classification of some of the non-experts as poor reciters. That will cast some doubt on one of the following:

(i) the significance of the asymmetry for the acoustic analysis of emphasis.

(ii) the formula adopted to quantify the asymmetry.

(iii) the accuracy of the experts' ratings of the non-experts.

4.2.3.4 Comparing the four trajectories of the non-experts

The PP trajectory is the highest among all the trajectories. In other words, we can continue to argue that it is the baseline from which the other three trajectories deviate. The distinction between styles is clearer for certain speakers than for some others who might have considered CA and MSA similar.

Not all the speakers showed asymmetrical transition patterns so as to show a qualitative difference between the EP and PE vowel trajectories. The EE/EP/PE trajectories of some speakers (e.g. N1, N2 and N4) get close together and become similar. Therefore, we expect that poor reciters colour the vowel with emphasis in the PE context and do not distinguish it from the vowel in the EP context.

4.2.4 Comparison between experts/CA and non-experts/MSA

4.2.4.1 PP/EE contexts

(i) PP context

One main objective in this study is to investigate the differences between experts and non-experts and between CA and MSA in the treatment of emphasis and plainness. By considering all the vowel trajectories so far examined it becomes clear that all the speakers exhibit similar high PP trajectories regardless of their expertise and the style they may be following. This assumption could be further supported by statistical analysis. Expertise, style and context were thus used as independent variables and the mean values of the vowel's onset, midpoint and offset as dependent variables. ANOVA showed no significant main effect for expertise and style and no significant interaction between the two variables. In other words, the vowel exhibits similar acoustic correlates with all speakers and styles and expertise is not of a special significance to the articulation of the vowel in completely plain environments.

(ii) Comparing PP/EE contexts

Consider the spectrograms of the utterances *biyadih* 'with his hand'(CA), *wayadih* 'and his hand' (MSA), *bararah* 'pious and just' (CA) and *tagha* 'he exceeded bounds' (MSA) in Figures (36) - (43) below. The speakers are an expert and a non-expert. The main difference between the completely plain and completely

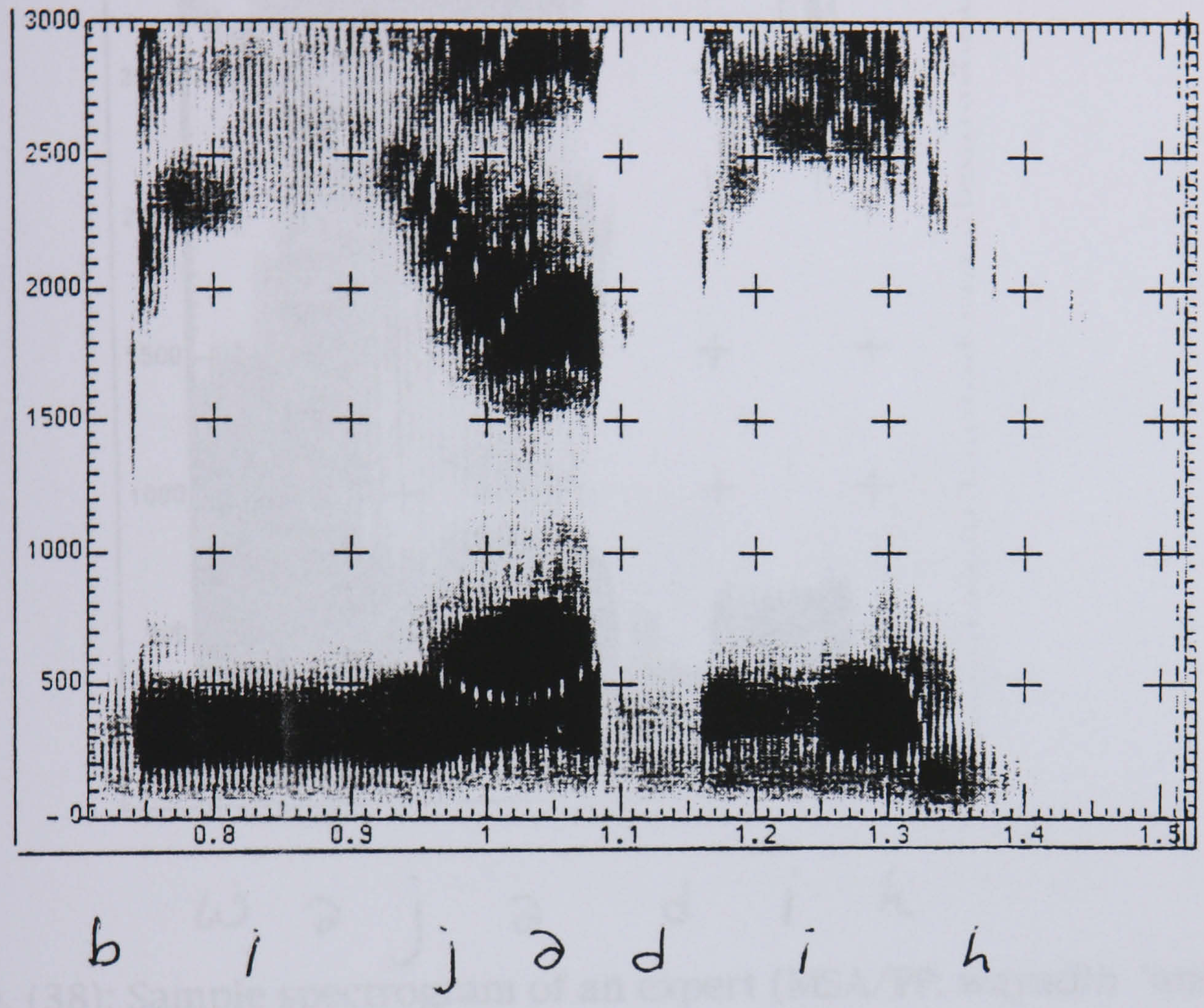


Fig. (36): Sample spectrogram of an expert (CA/PP: *biyadih* 'with his hand')

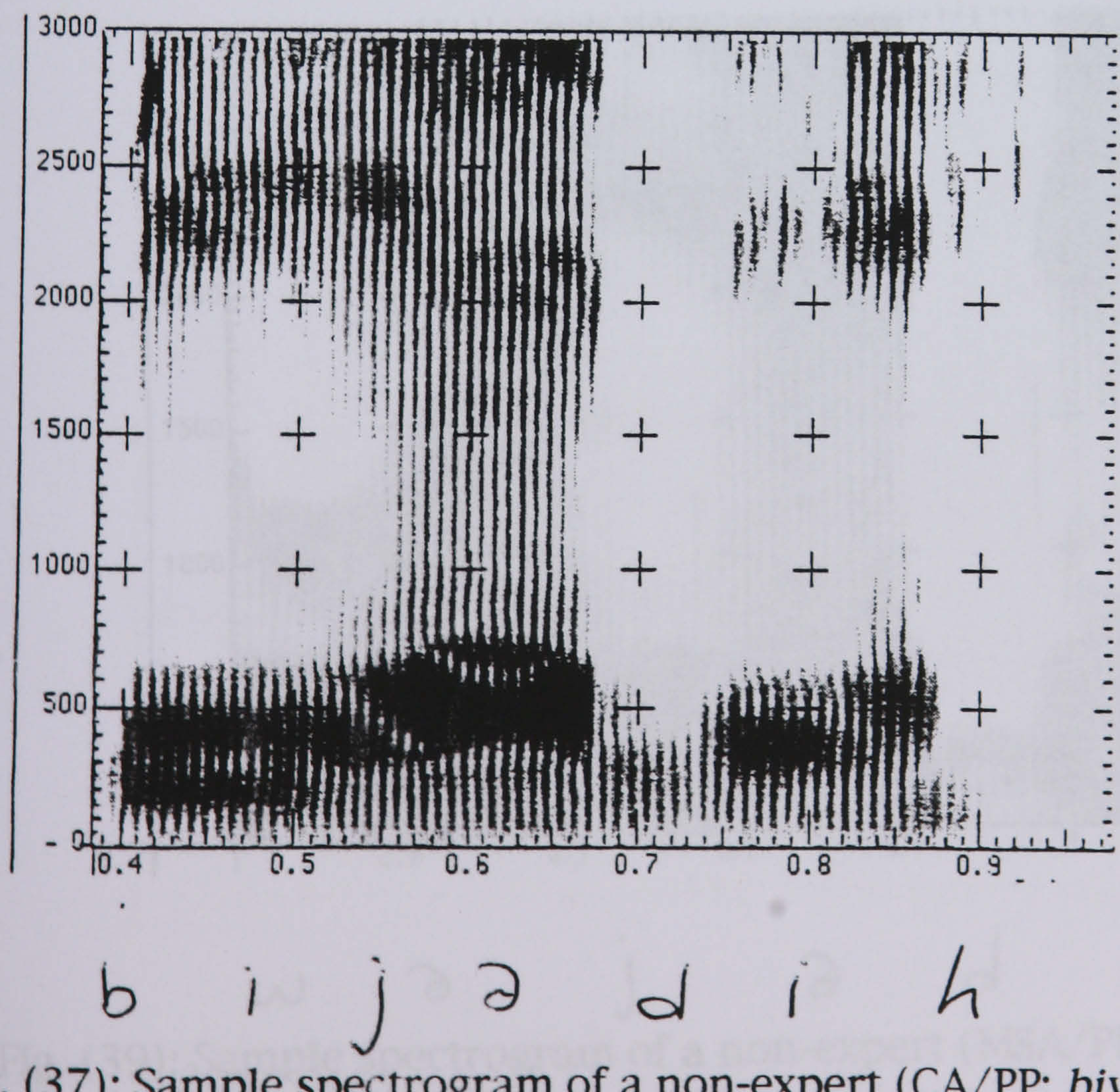


Fig. (37): Sample spectrogram of a non-expert (CA/PP: *biyadih* 'with his hand')

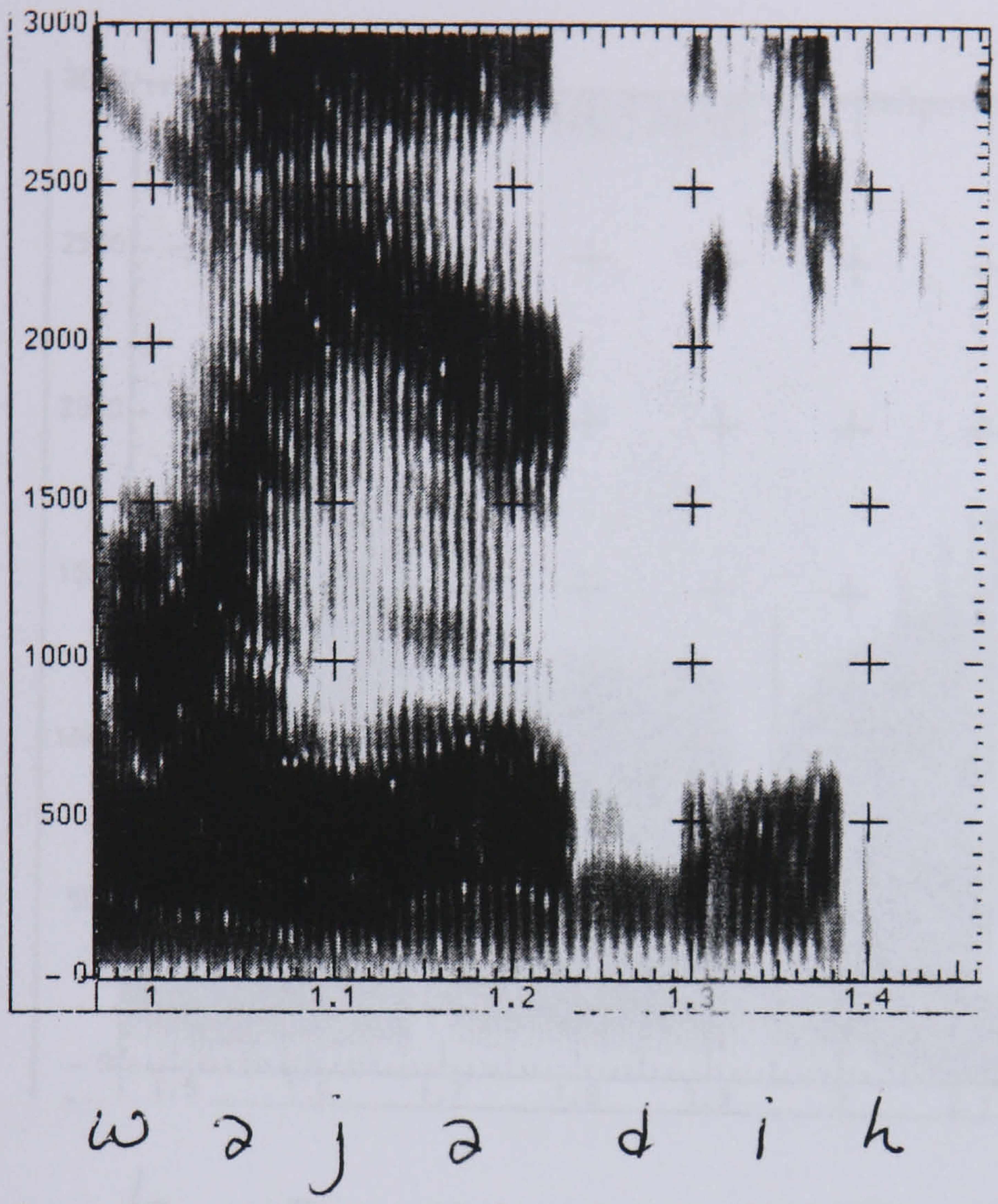


Fig. (38): Sample spectrogram of an expert (MSA/PP: *wayadih* 'and his hand')

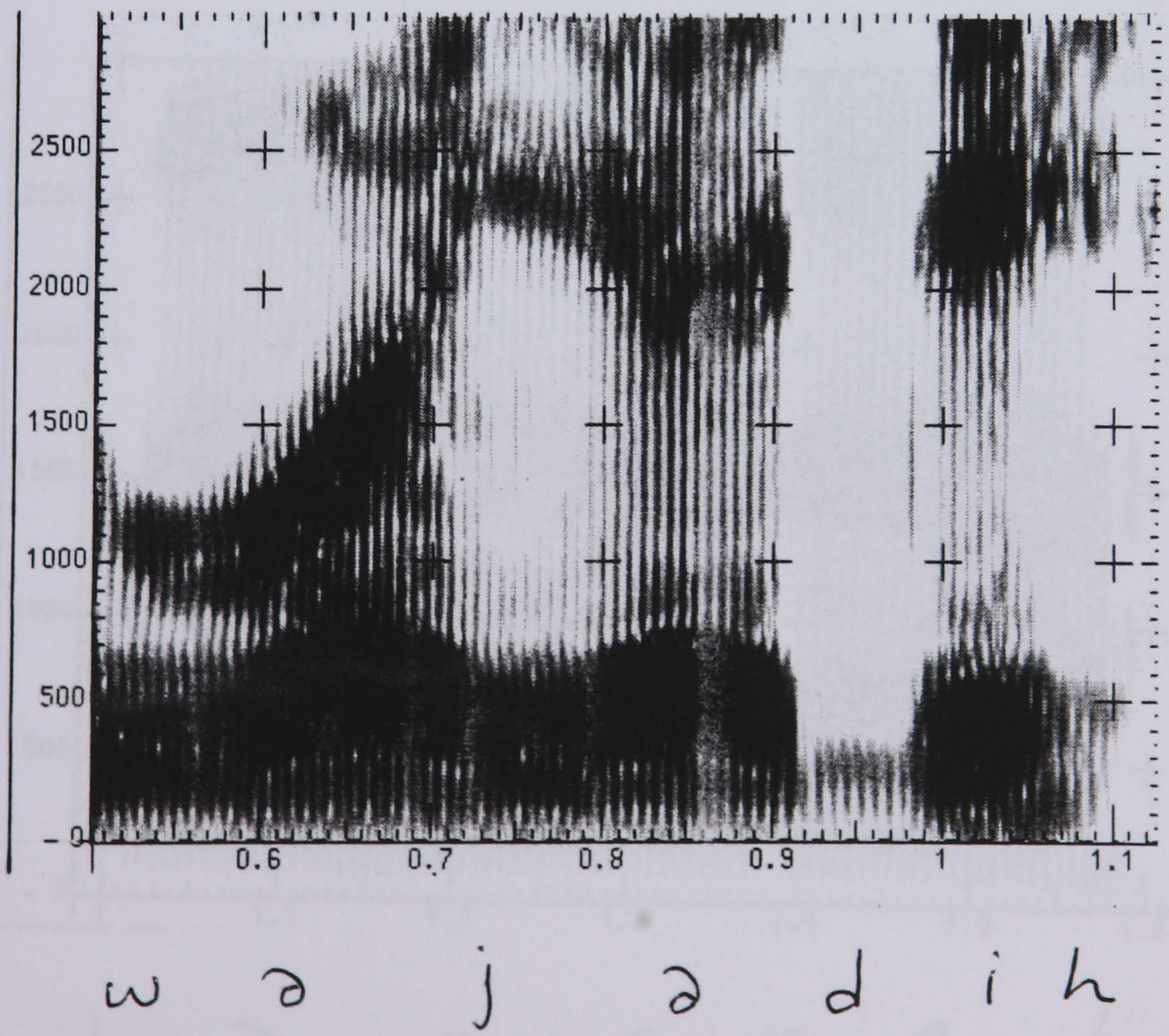
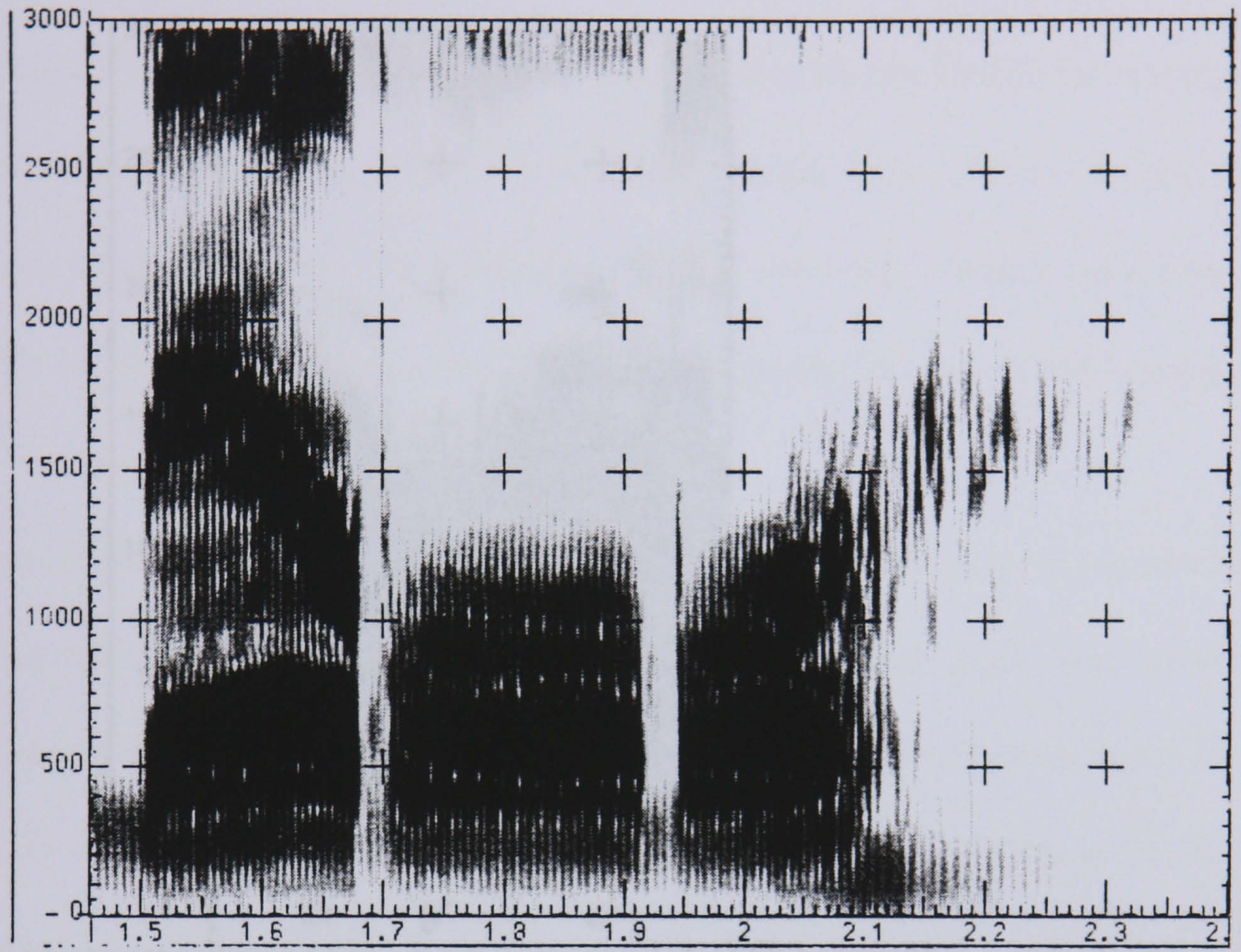
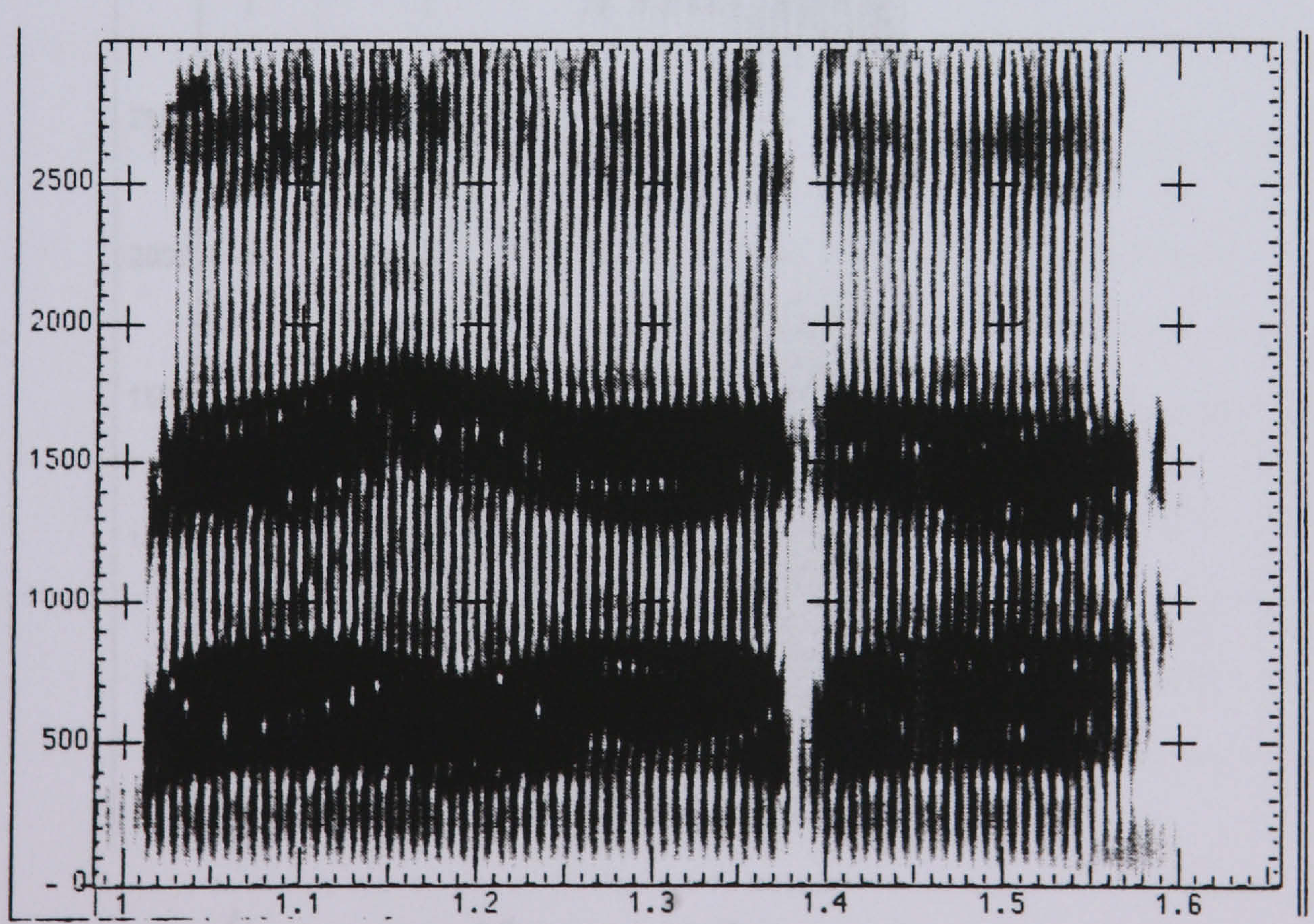


Fig. (39): Sample spectrogram of a non-expert (MSA/PP: *wayadih* 'and his hand')



b ə ṛ a ṛ a h

Fig. (40): Sample spectrogram of an expert (CA/EE: *bararah* 'pious and just')



b ə ṛ a ṛ a h

Fig. (41): Sample spectrogram of a non-expert (CA/EE: *bararah* 'pious and just')

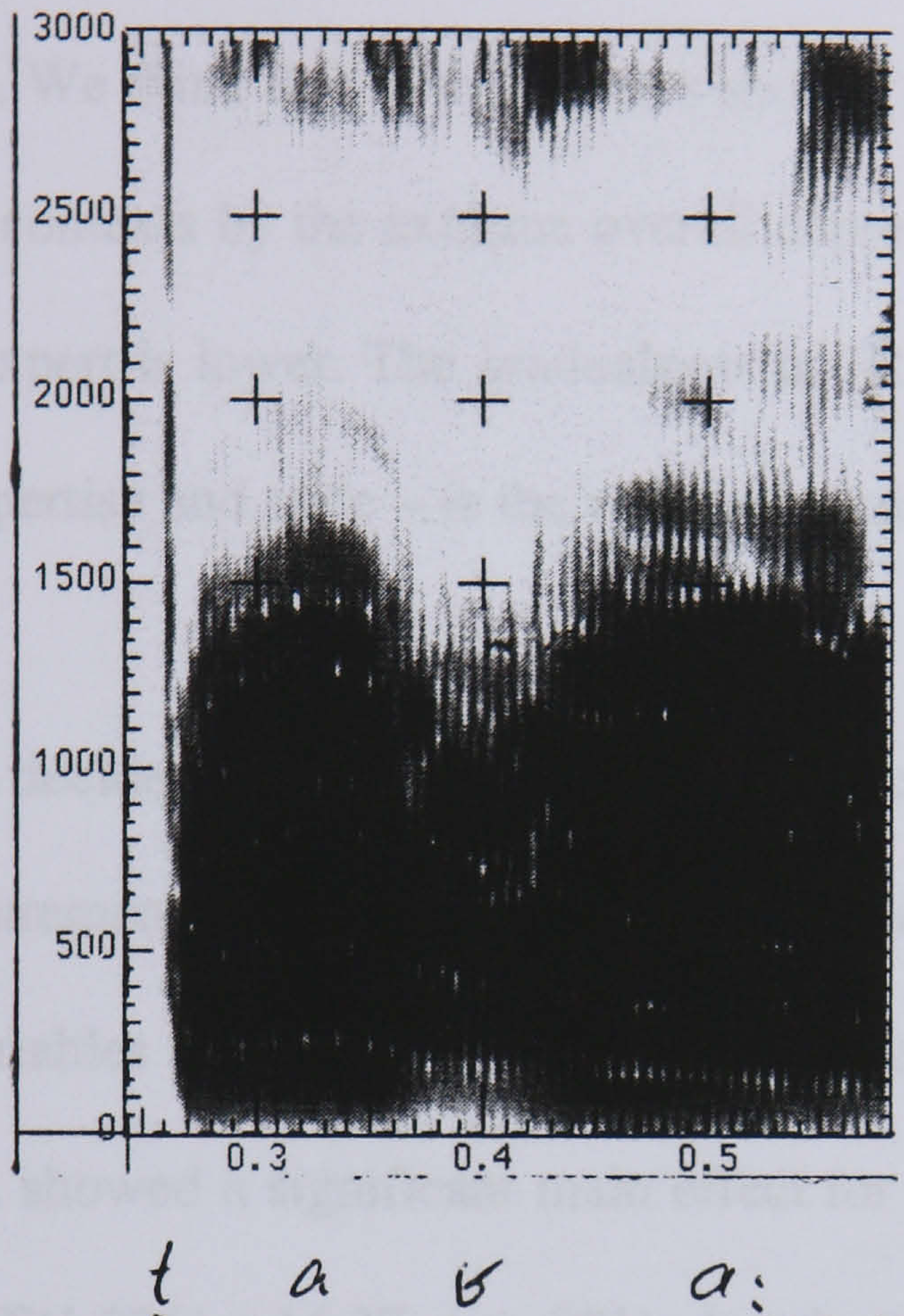


Fig. (42): Sample spectrogram of an expert (CA/EE: *tagha* 'he exceeded bounds')

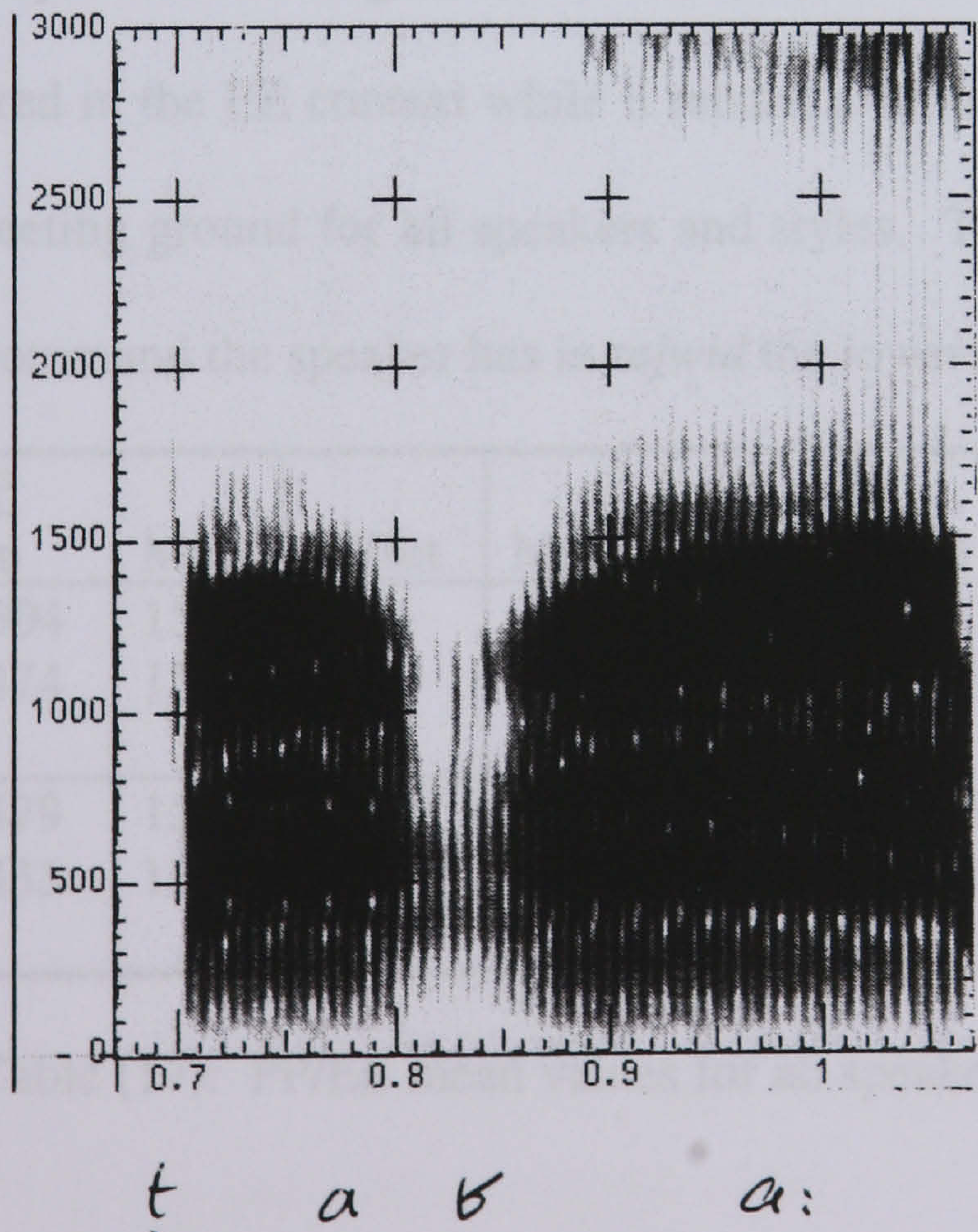


Fig. (43): Sample spectrogram of a non-expert (CA/EE: *tagha* 'he exceeded bounds' emphatic environments is the extreme lowering of F2 in the latter from around 1600 Hz-1800 Hz for the PP context (both speakers) to 1000 Hz for the expert and 1500 Hz for the non-expert. We think that both speakers show a significant distinction between PP and EE vowel contexts by the extreme overall depression of F2. However, the EE trajectory of the expert is lower. The gradualness of F2 lowering - which presumably correlates with expertise and style – is the result of increasing the size of the emphatic gesture.

In order to decide whether the difference between speakers/styles is significant the relevant measurements were tested statistically using expertise, style, and context as independent variables and the mean value of the onset, mid and offset as dependent variable. ANOVA showed a significant main effect for expertise ($F(1,236) = 32.86$, $p < .001$) and style ($F(1,236) = 16.27$, $p < .001$), but there was no significant interaction between the two variables. Table (17) shows the mean values for all speakers. By plotting their trajectories in Figures (44) and (45) below it can be seen that F2 is gradually lowered in the EE context while it retains a similar height in the PP context which is the meeting ground for all speakers and styles. The more educated the style and the better command the speaker has in *tajwid* the lower the EE trajectories.

Sp Style	PP On	Mid	Offset	Mean	EE On	Mid	Offset	Mean	Diff
Exp CA	1504	1548	1536	1529	922	999	936	952	577
MSA	1474	1564	1561	1533	1005	1080	1019	1034	499
N-Exp CA	1479	1512	1519	1503	1029	1093	1059	1060	443
MSA	1435	1520	1556	1537	1058	1133	1110	1100	437

Table (17): PP/EE mean values for all speakers

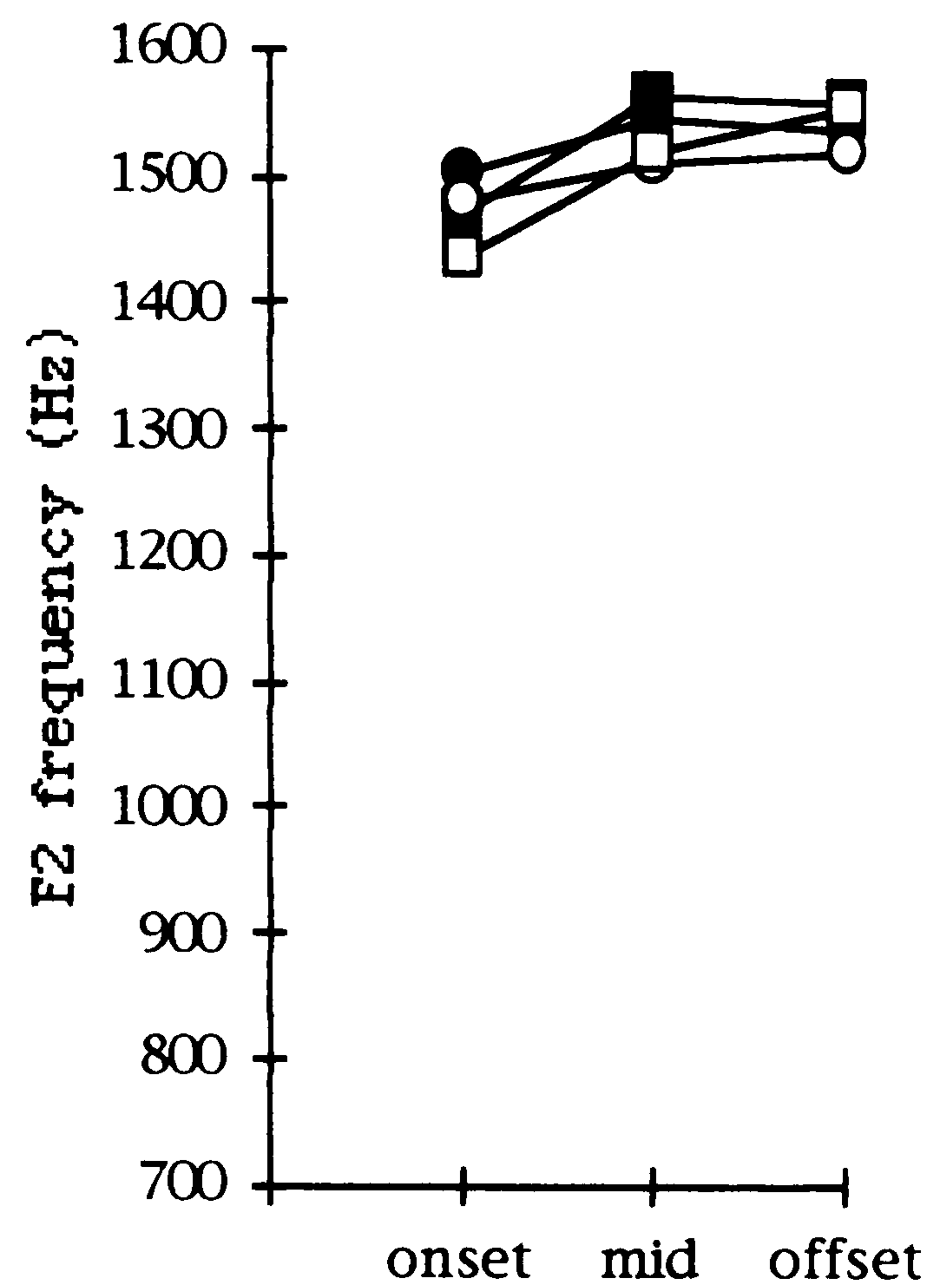
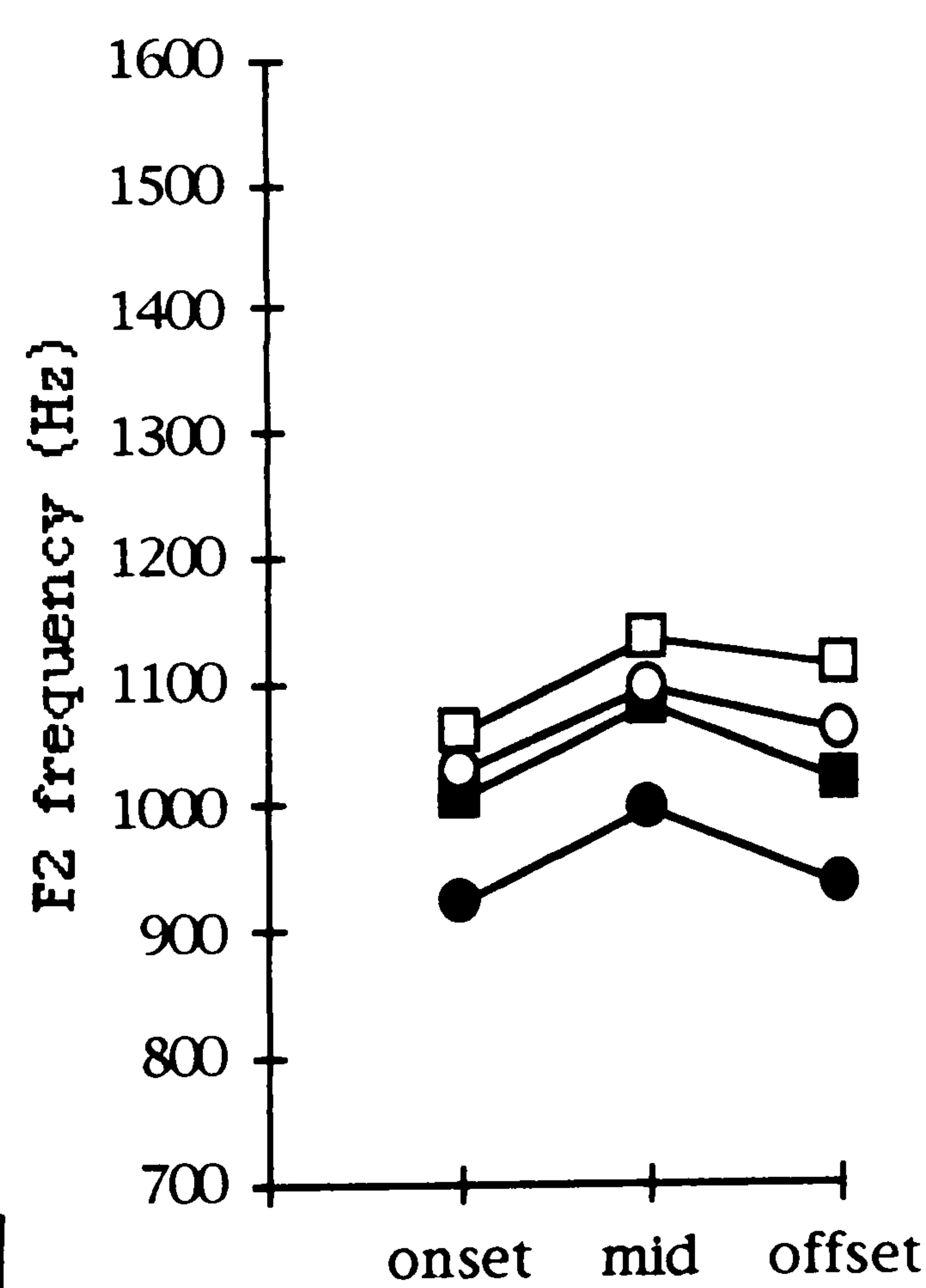


Fig. (44): All speakers/styles
(PP context)



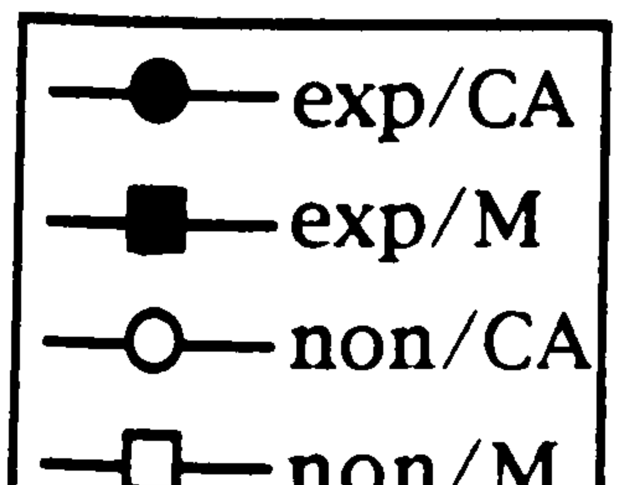


Fig. (45): All speakers/styles
(EE context)

4.2.4.2 EP/PE contexts

(i) EP context

The size or amount of change from the onset to the offset of the vowel is apparently crucial to the difference between different speakers and styles. This reflects the phonetic nature of CA which motivates a larger emphatic gesture in the EP context for CA than for MSA. Expertise, style and context were used as independent variables and the values of $\Delta F2$ as dependent variable in ANOVA. There was a significant main effect for expertise ($F(1,236) = 9.15$, $p < .01$) and style ($F(1,236) = 4.80$, $p < .05$), but there was no significant interaction between the two variables

(ii) Comparing EP/PE contexts

Consider the spectrograms shown in Figures (46) - (57) of the utterances *faqāla* 'then he said', *# ttakhadha/'ittakhadha* 'he followed/selected' and *baṭan* 'hidden' in the two styles when produced by an expert and a non-expert reciter. In the first syllable in *faqāla* (Figures (46) and (47)) in CA the expert maintains a high F2 of approximately 1450 Hz whereas the non-expert exhibits a slightly smaller frequency value of 1300 Hz. The formant transition towards the end of the vowel is steeper for the expert especially when we compare the space that separates between F1 and F2 in his spectrogram from that in the non-expert's. In the second syllable of the same utterance, both speakers get their F2 frequency values lowered. But the lowering of the formant is greater for the expert. However, we are not quite sure whether the difference between the two speakers is significant. Particularly with the expert, we

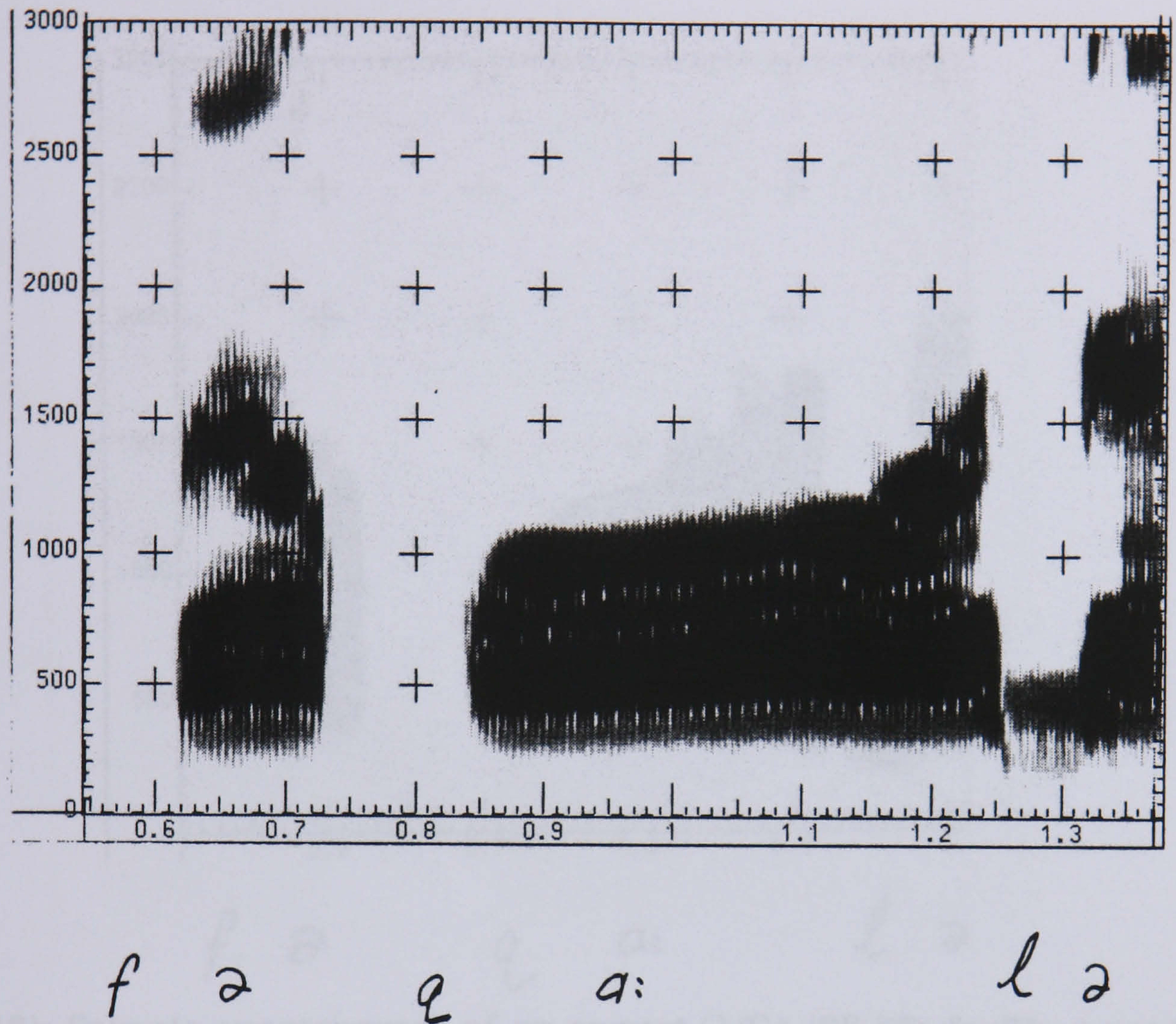


Fig. (46): Sample spectrogram of an expert (CA/PE-EP: *faqāla* 'and he said')

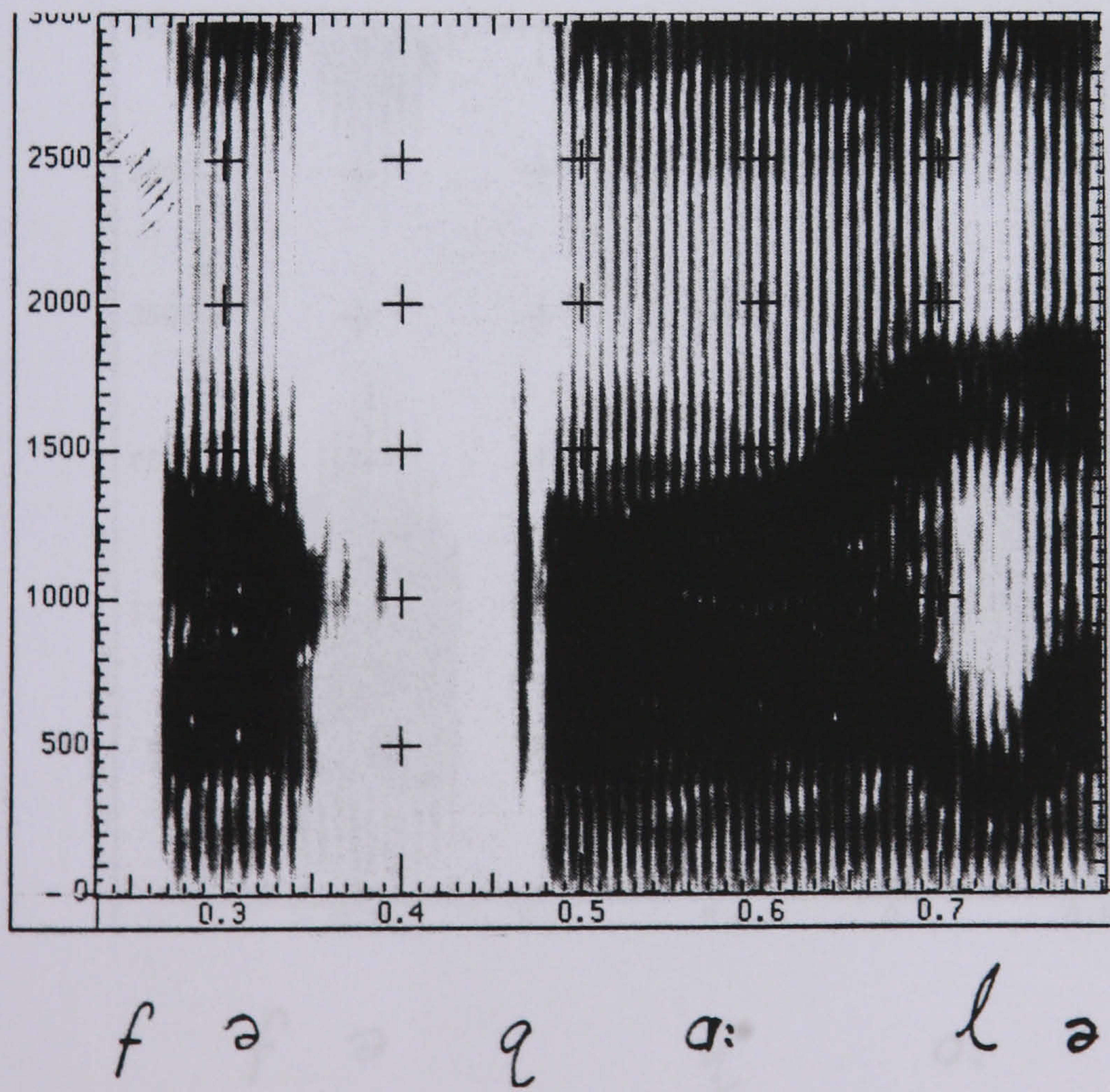


Fig. (47): Sample spectrogram of a non-expert (CA/PE-EP: *faqāla* 'and he said')

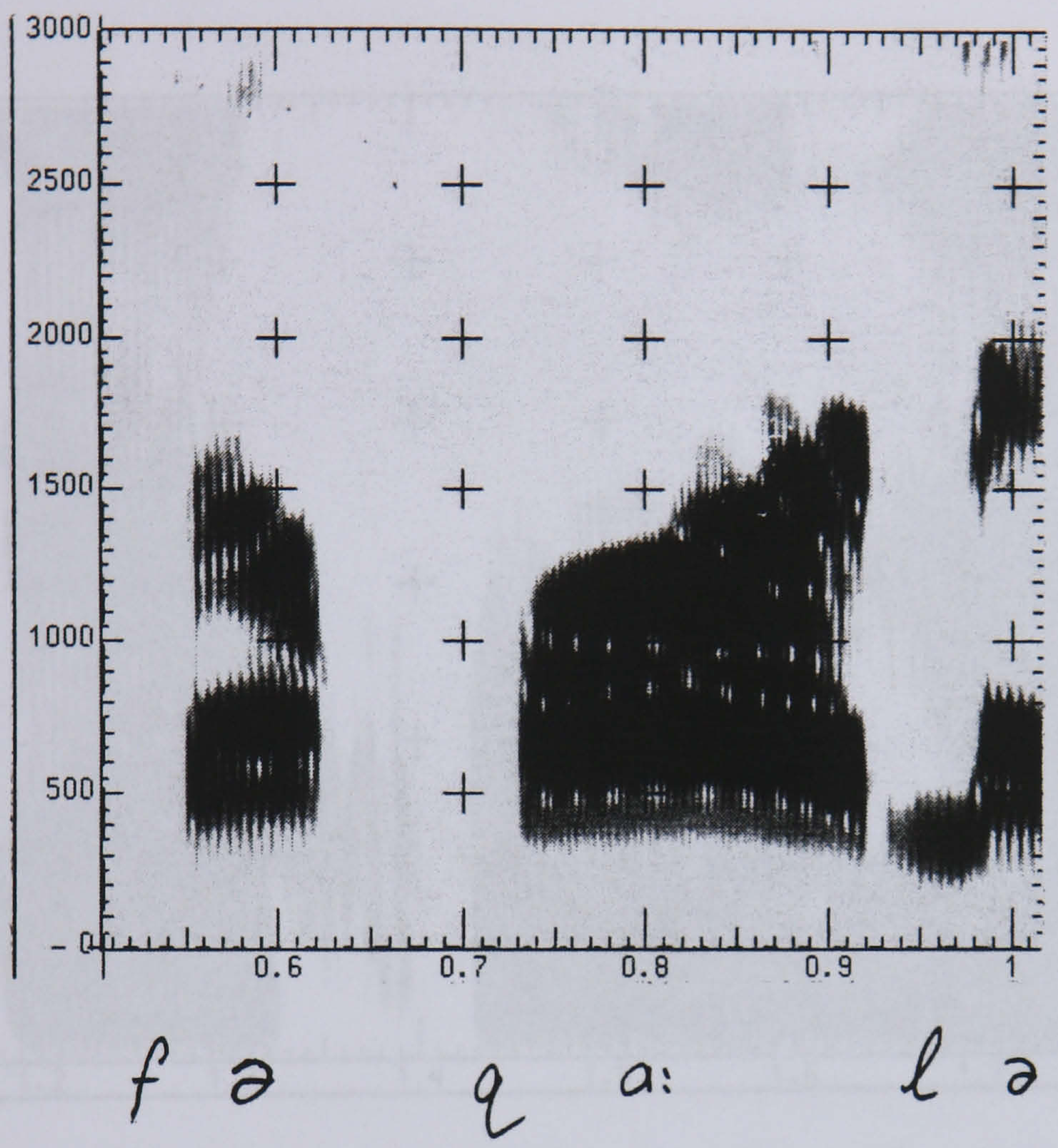


Fig. (48): Sample spectrogram of an expert (MSA/PE-EP: *faqāla* 'and he said')

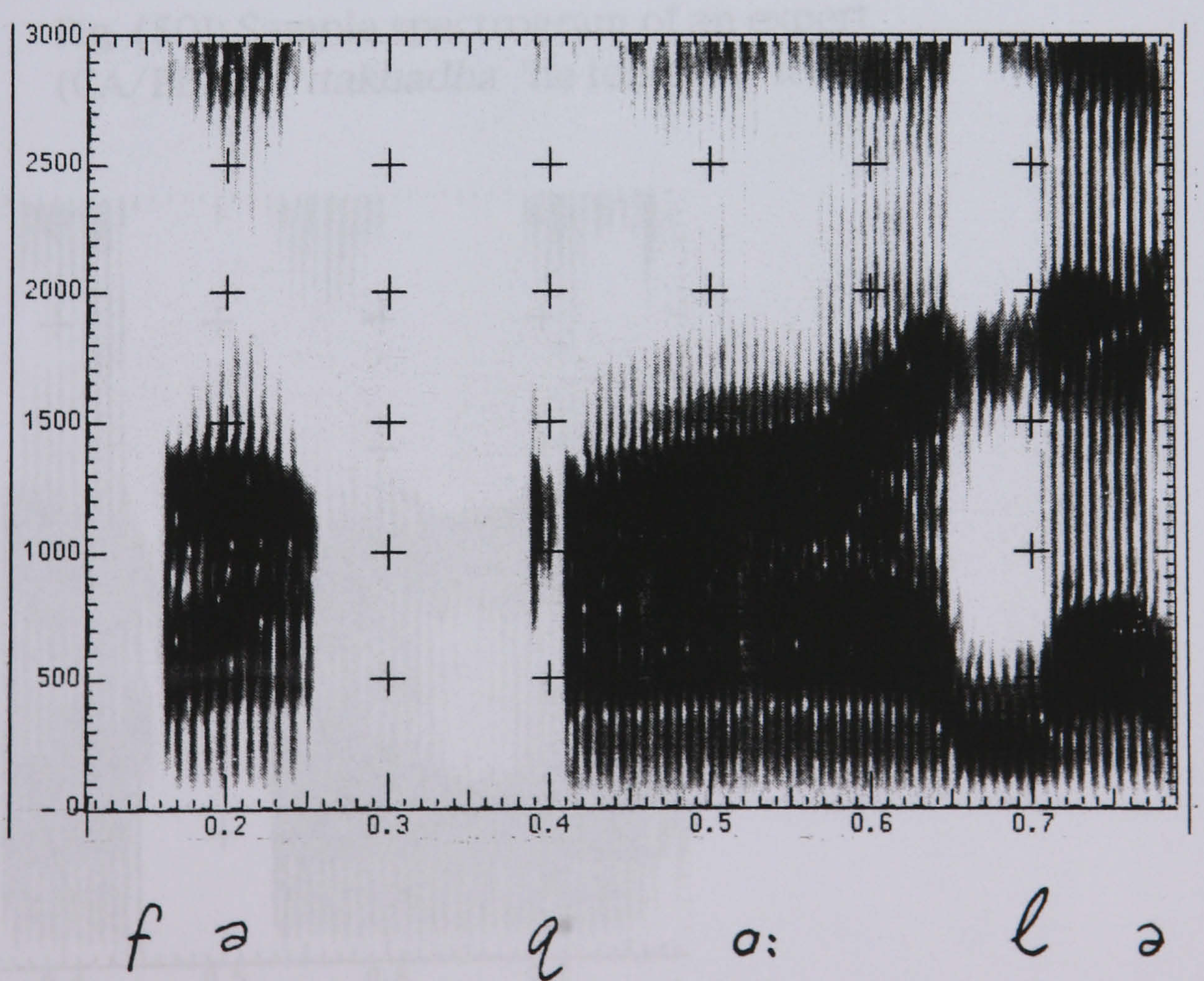


Fig. (49): Sample spectrogram of a non-expert (MSA/PE-EP: *faqāla* 'and he said')

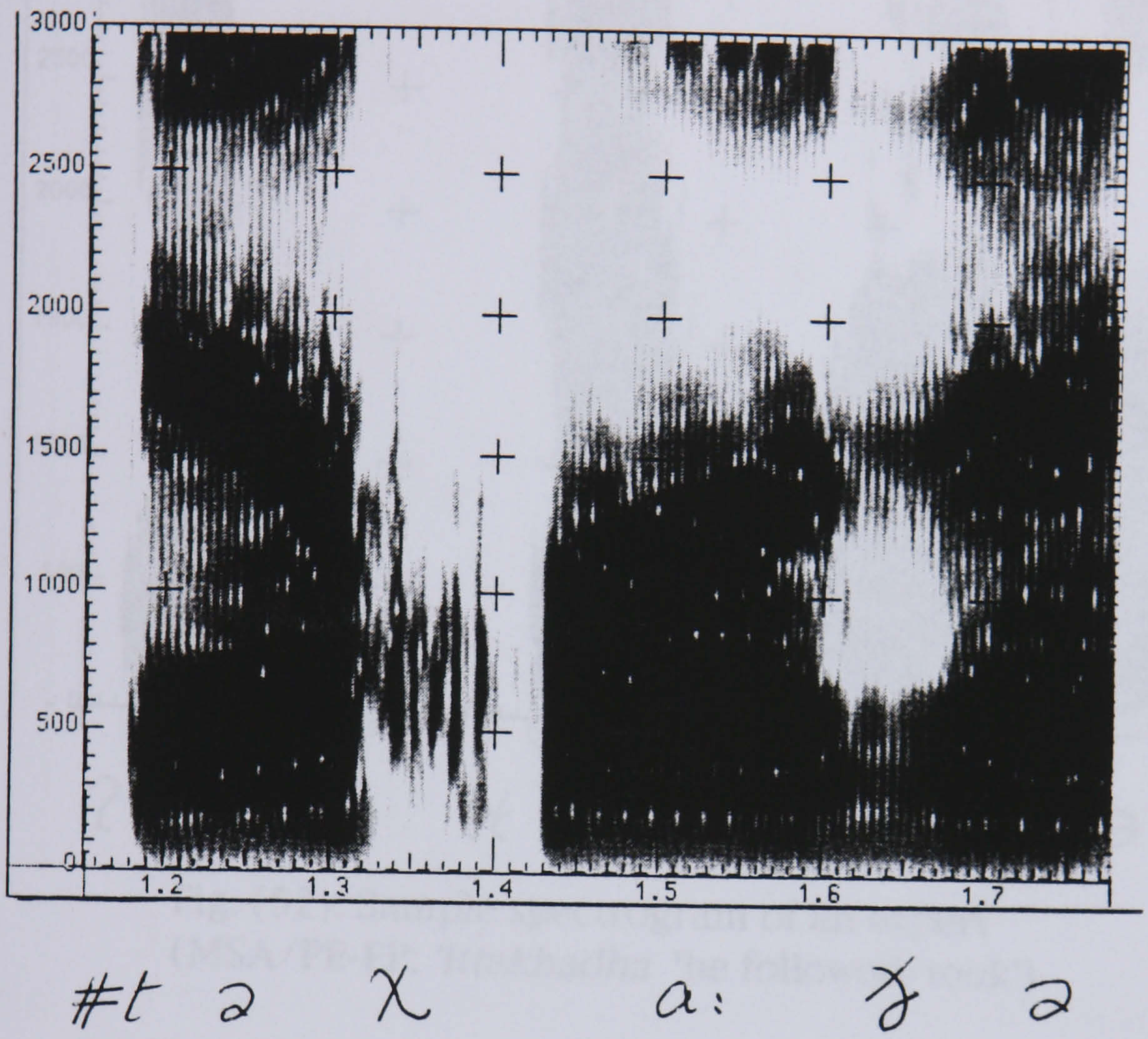


Fig. (50): Sample spectrogram of an expert
(CA/PE-EP:#'*ttakhadha* 'he followed/took')

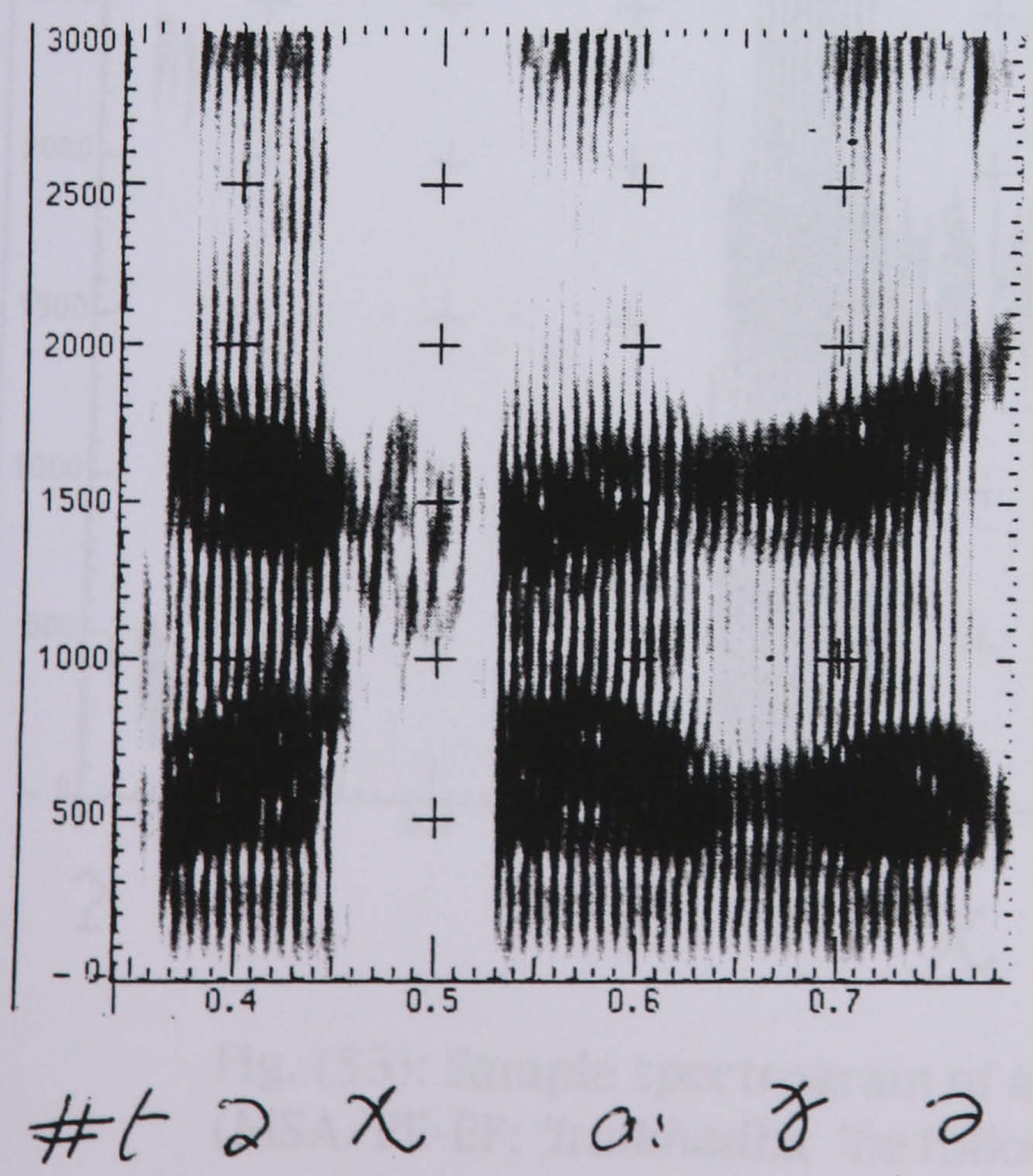


Fig. (51): Sample spectrogram of a non-expert
(CA/PE-EP:#'*ttakhadha* 'he followed/took')

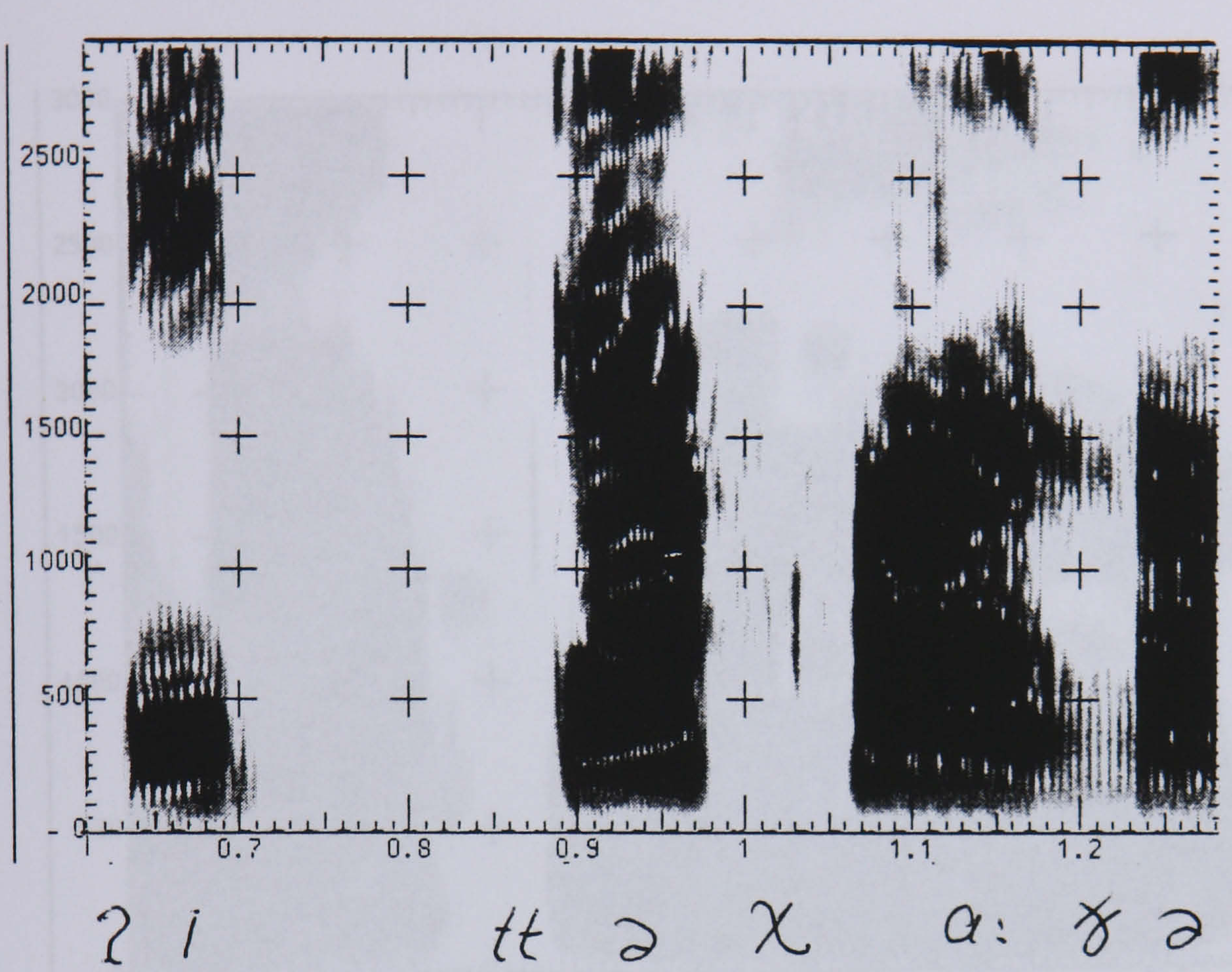


Fig. (52): Sample spectrogram of an expert
(MSA/PE-EP: *'ittakhadha* 'he followed/took')

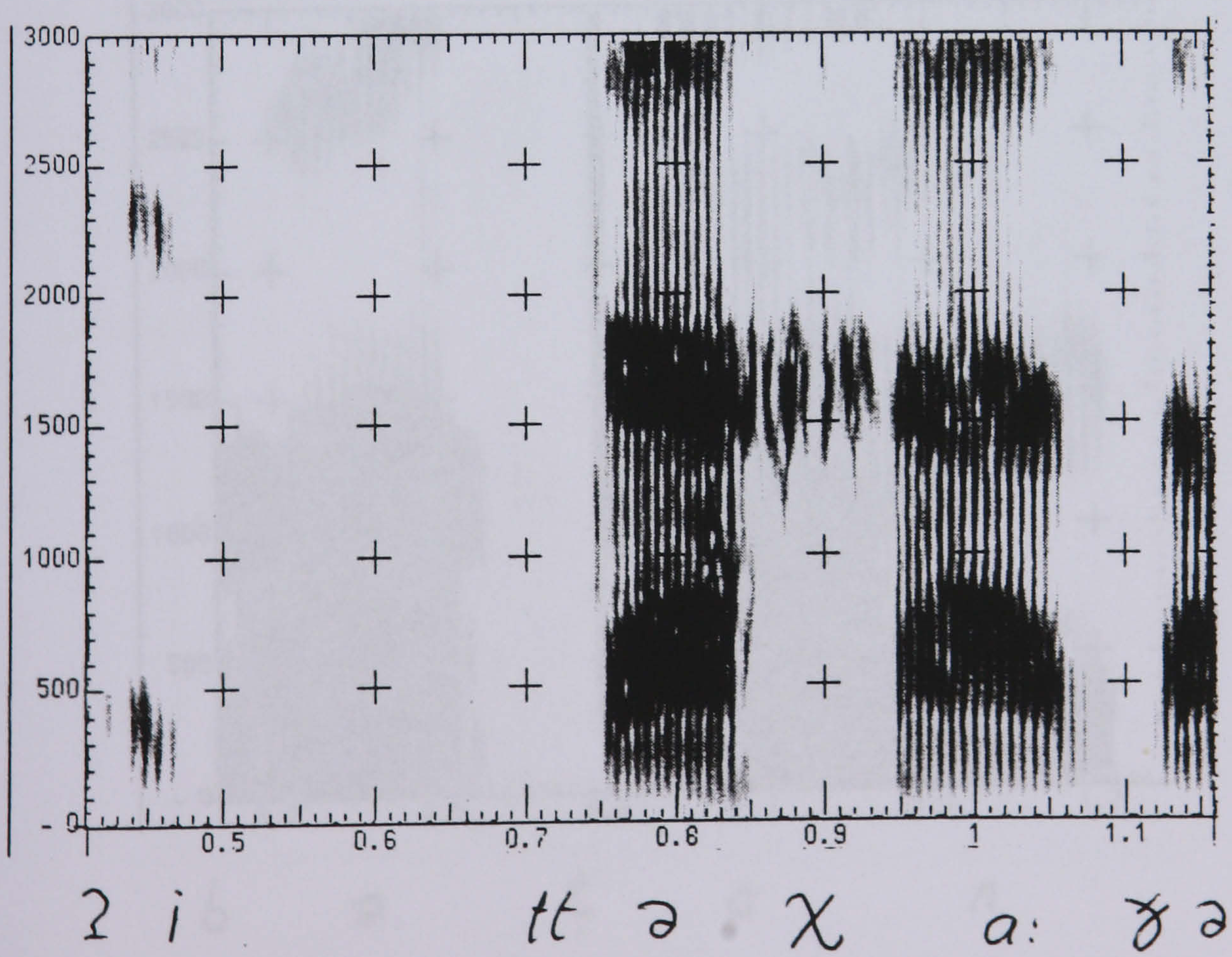


Fig. (53): Sample spectrogram of a non-expert
(MSA/PE-EP: *'ittakhadha* 'he followed/took')

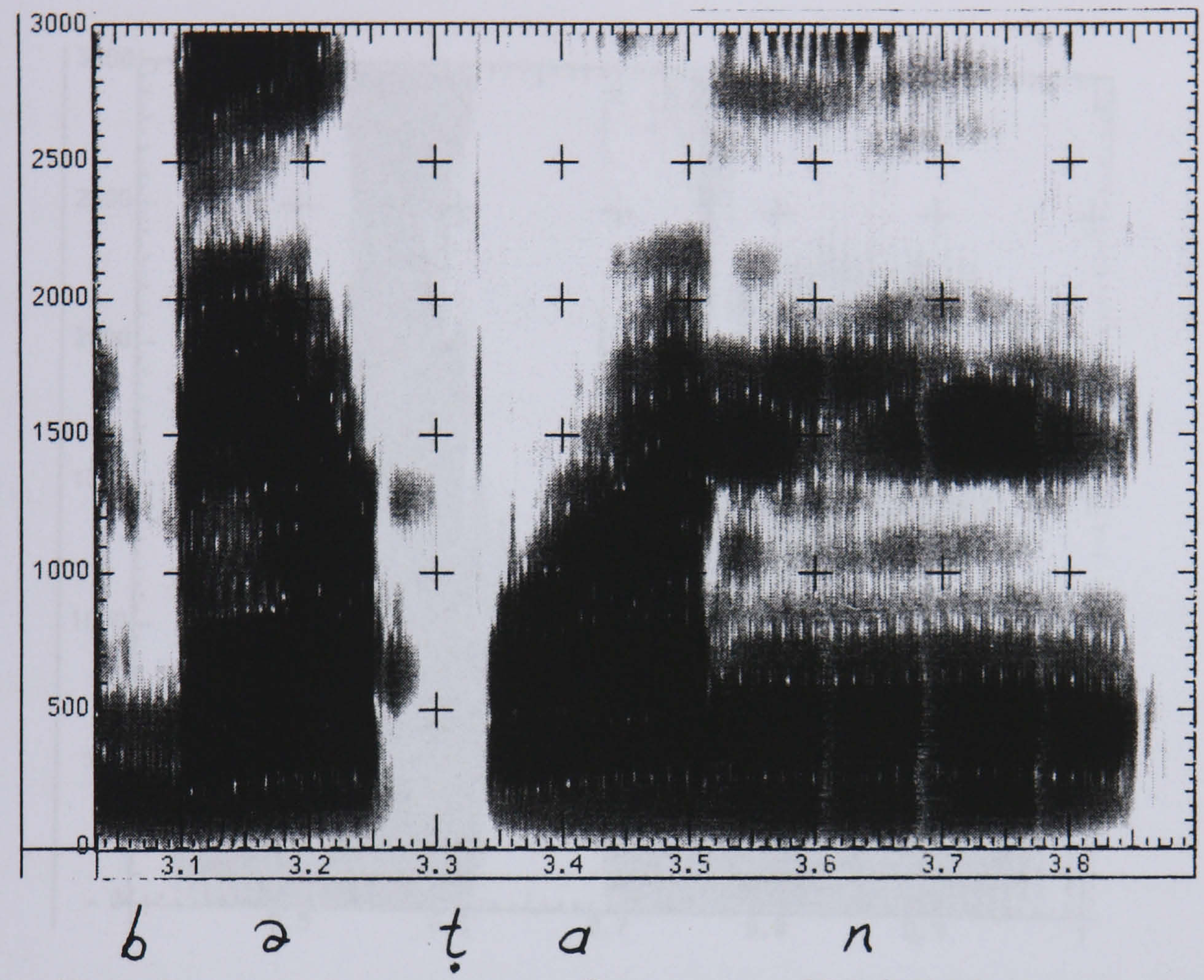


Fig. (54): Sample spectrogram of an expert (CA/PE-EP: *baṭan* 'hidden')

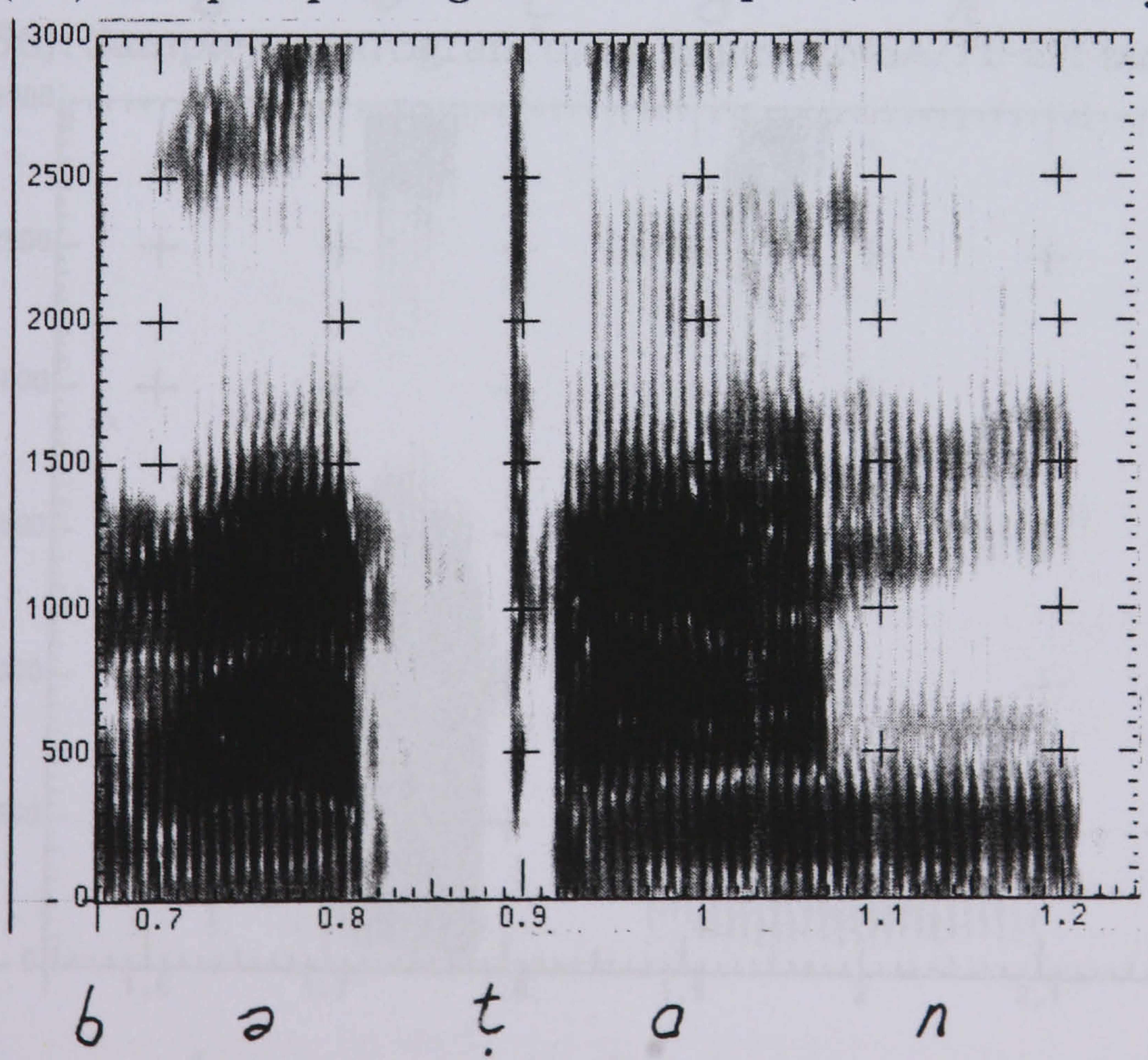


Fig. (55): Sample spectrogram of a non-expert (CA/PE-EP: *baṭan* 'hidden')

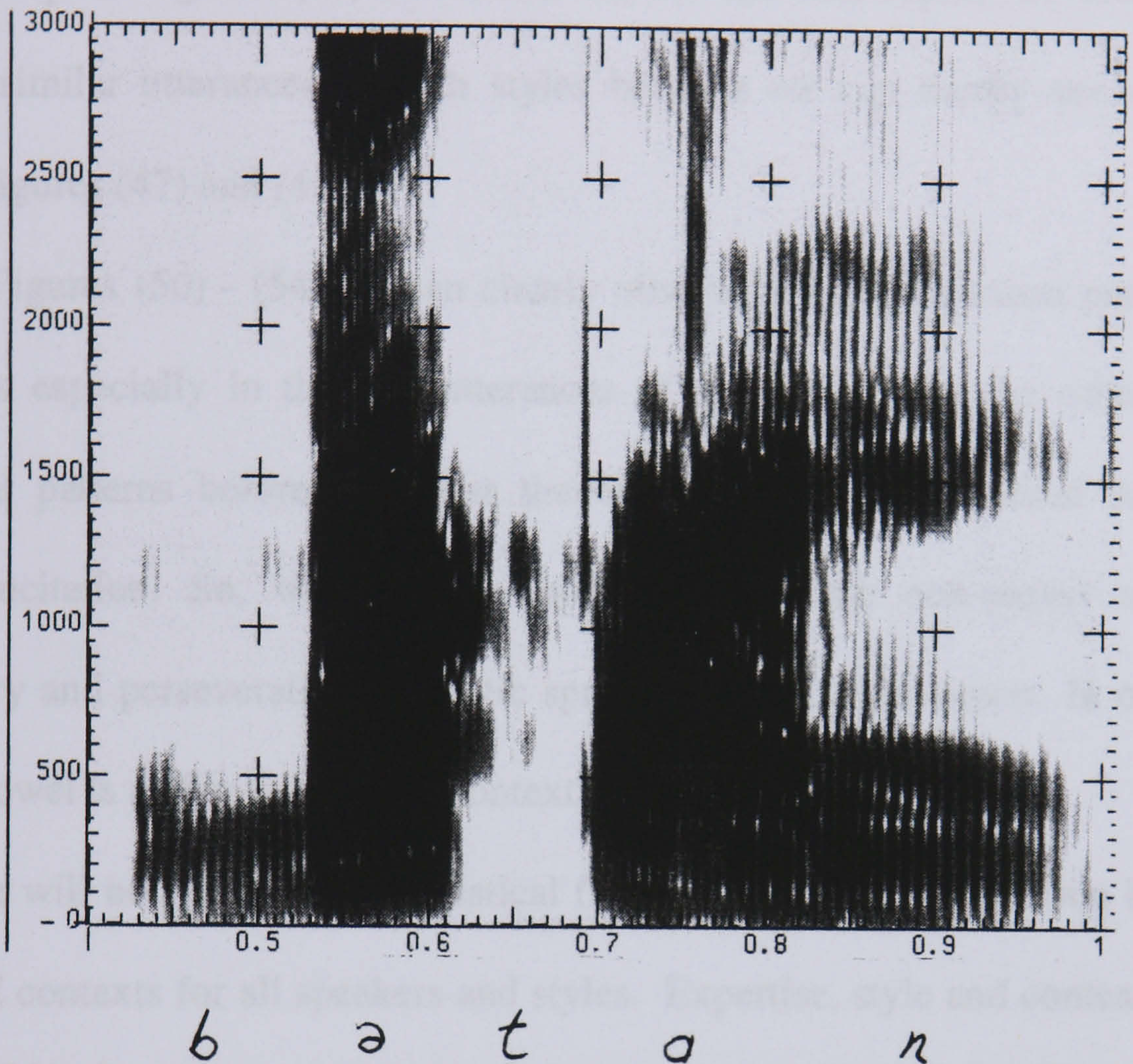


Fig. (56): Sample spectrogram of an expert (MSA/PE-EP: *batan* 'hidden')

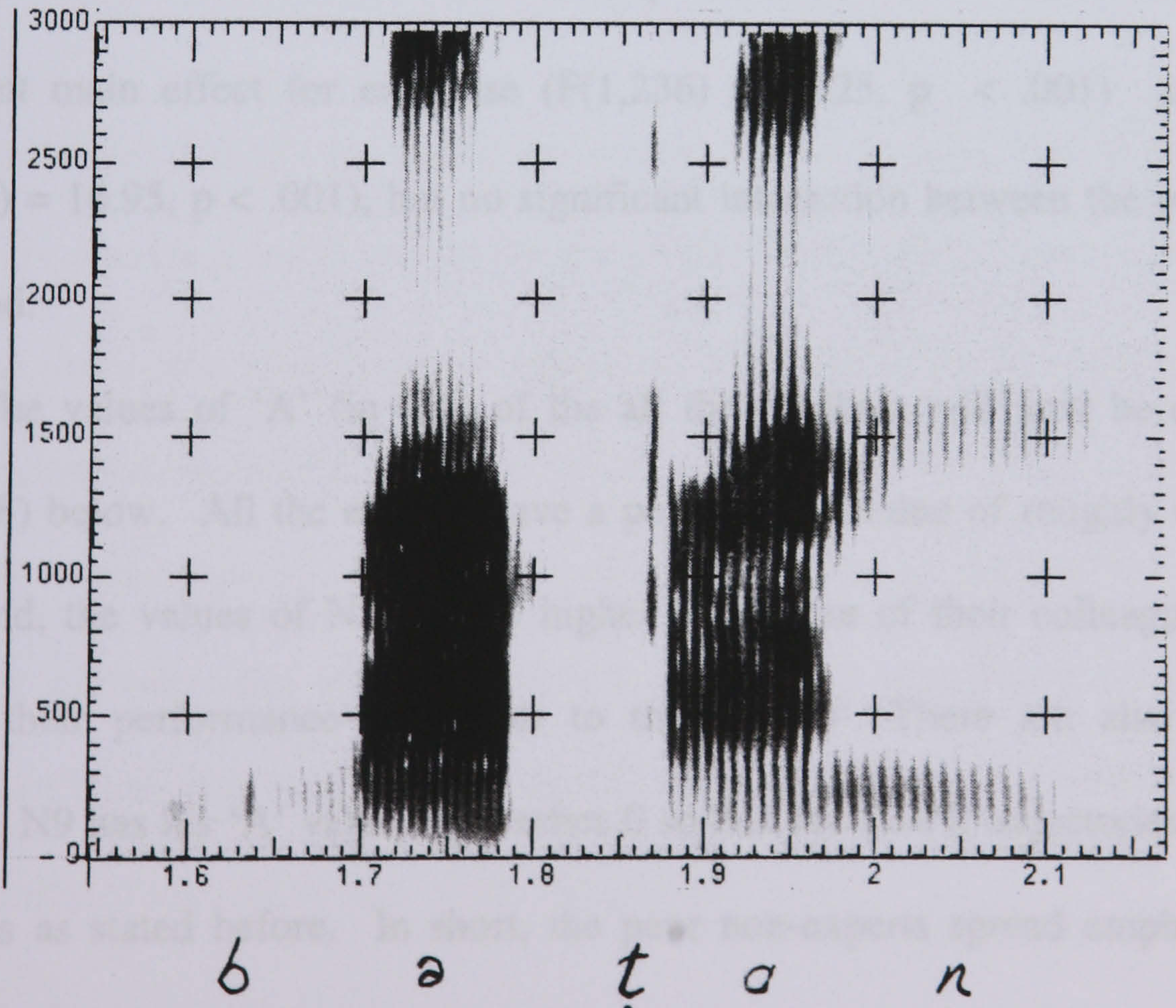


Fig. (57): Sample spectrogram of a non-expert (MSA/PE-EP: *batan* 'hidden') assume that the quality of the vowel before and after the [q] is clearly different and that this speaker differentiates between CA and MSA since his F2 value is lower for the former (compare Figures (46) and (48)). As for the non-expert, he seems to have produced similar utterances in both styles because we can hardly see a difference between Figures (47) and (49).

In Figures (50) - (54) we can clearly observe the asymmetrical patterns of the trajectories especially in the CA utterances of the expert. On the other hand, the transitional patterns before and after the emphatics are symmetrical for the non-expert's recitation. So, we get the impression that the non-expert allows both anticipatory and perseverative emphatic spreading, unlike the expert. In other words, no plain vowel is realized in the PE context by the non-expert.

We will now turn to the statistical findings about the comparison between the EP and PE contexts for all speakers and styles. Expertise, style and context were used as independent variables and ΔF2 as dependent variable. ANOVA showed a significant main effect for expertise ($F(1,236) = 23.25$, $p < .001$) and for style ($F(1,236) = 16.95$, $p < .001$), but no significant interaction between the two variables was found.

The values of 'A' (in CA) of the all the speakers will now be compared in Table (18) below. All the experts have a positive 'A' value of roughly 0.5. On the other hand, the values of N5-N8 are higher than those of their colleagues, possibly because their performance is similar to the experts'. There are also unexpected findings. N9 has his 'A' value approaches 0 so that his EP/PE trajectories cross at the midpoints as stated before. In short, the poor non-experts spread emphasis in both directions. On the other hand, it is clear that some speakers (e.g. N5 and N8) behave more like the experts.

Speaker	A	Speaker	A
El	0.48	N1	0.17
E2	0.46	N2	-0,8
E3	0.57	N3	-0,42
E4	0.61	N4	-4,42
E5	0.38	N5	0.55
E6	0.48	N6	0.38
		N7	0.38
		N8	0.52
		N9	0.03

Table (18): Values representing the asymmetry in CA (all speakers)

Therefore, it might be useful to use 'A' values in ANOVA and compare the different speakers and styles as was done with $\Delta F2$ above where the analysis showed a significant main effect for expertise and style. Expertise, style and context were thus used as independent variables and the values representing the sharpness of the elbow in the PE trajectories as dependent variables. Unlike the $\Delta F2$ which we used as dependent variable (see above) ANOVA showed no significant main effect for expertise and style and there was no significant interaction between the two variables. These findings could imply one of the following:

(i) ΔF2 is a more reliable correlate to study the difference between the experts and non-experts and between CA and MSA than the asymmetry; and this is why there was a significant main effect for expertise and style when it was used as a dependent variable, or

(ii) there may be an even better way of quantifying the asymmetry.

By considering both (i) and (ii) above it can be said that the amount of change throughout the PE trajectory is not the only difference between the experts' recitations and those of ordinary speakers. If only the amount of change is considered we will unfortunately have to discard the phonological behaviour of the vowel which we hypothesize resists emphasis in the PE context and coarticulates with it in the EP context. However, one may argue that the vowel's resistance to emphatic coarticulation is rather expressed by the larger size of ΔF2 where the formant value closest to the P target is consistently higher for experts' recitation style and the formant value closest to the E target is lower for experts' recitation style. Nevertheless, the asymmetry - which is shared by all the experts and the good non-experts – will apparently remain a special phenomenon to report in the present study. The asymmetry could to the least shed light on the phonological aspect of CA, and reflect the *tajwid* definition being as the discipline which gives segments their full values.

The difference between speakers or styles of different categories in the EP/PE context is generally a function of the E target. Consider ΔF2 measurements in Table (19) and the trajectories in Figures (58) and (59) which are based on the values shown in the table. Note that the trajectories reflect the variability of emphasis and it further shows that the speaker is either increasing the size of the emphatic gesture in the EP context or of decreasing it in the PE context. Particularly in the latter, it can be assumed that some speakers resist emphasis by retaining as high P target as possible and that emphasis spreads perseveratively.

Speaker	Style	EP On	Mid	Off	ΔF2	PE On	Mid	Off	ΔF2
Experts	CA	881	1056	1264	383	1361	1295	1001	360
	MSA	946	1089	1225	279	1306	1218	1059	247
Non-exp	CA	1008	1135	1260	252	1259	1205	1033	226
	MSA	1062	1192	1238	176	1171	1151	1071	101

Table (19): EP/PE mean values of all speakers

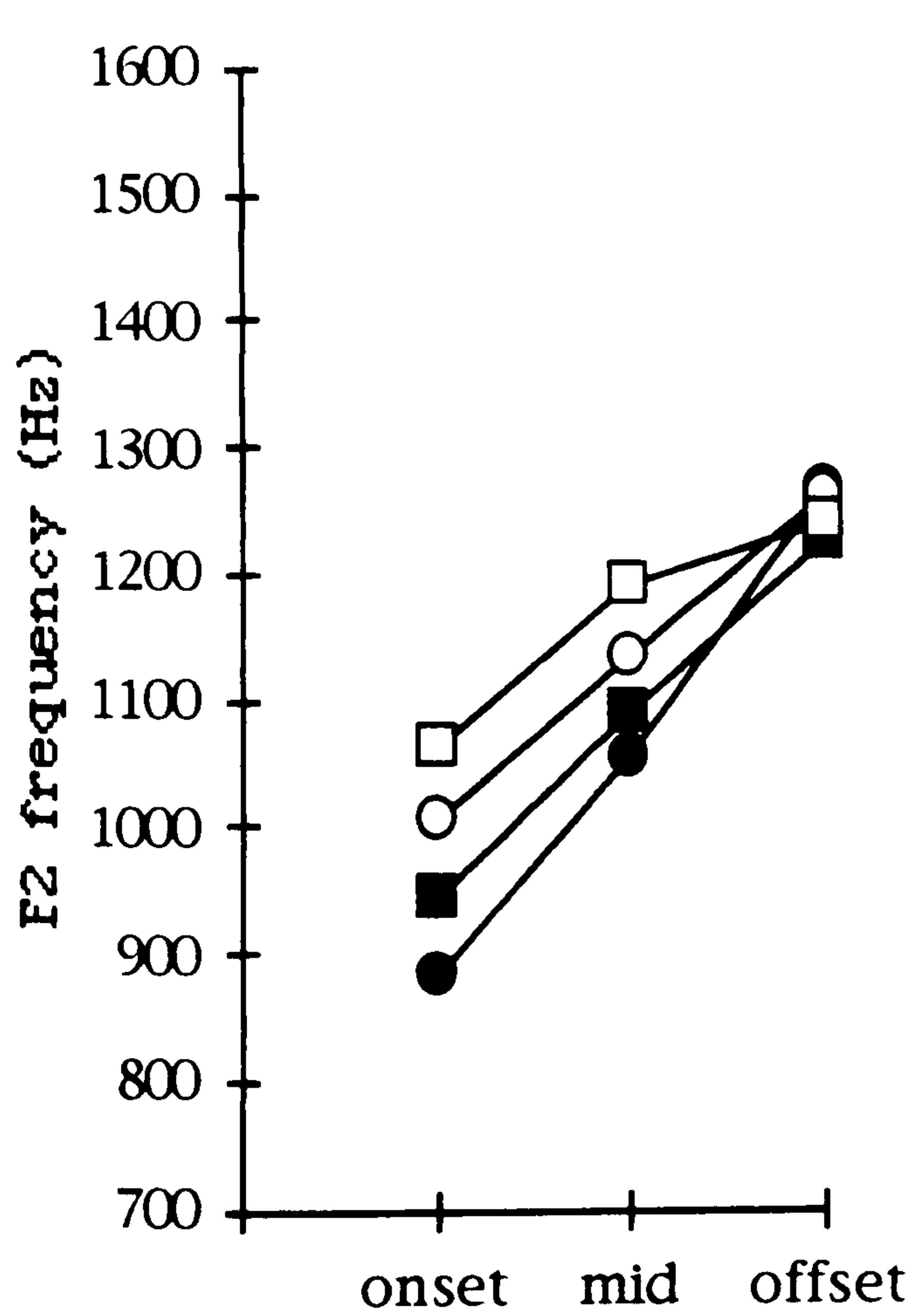


Fig. (58): All speakers/styles (EP context)

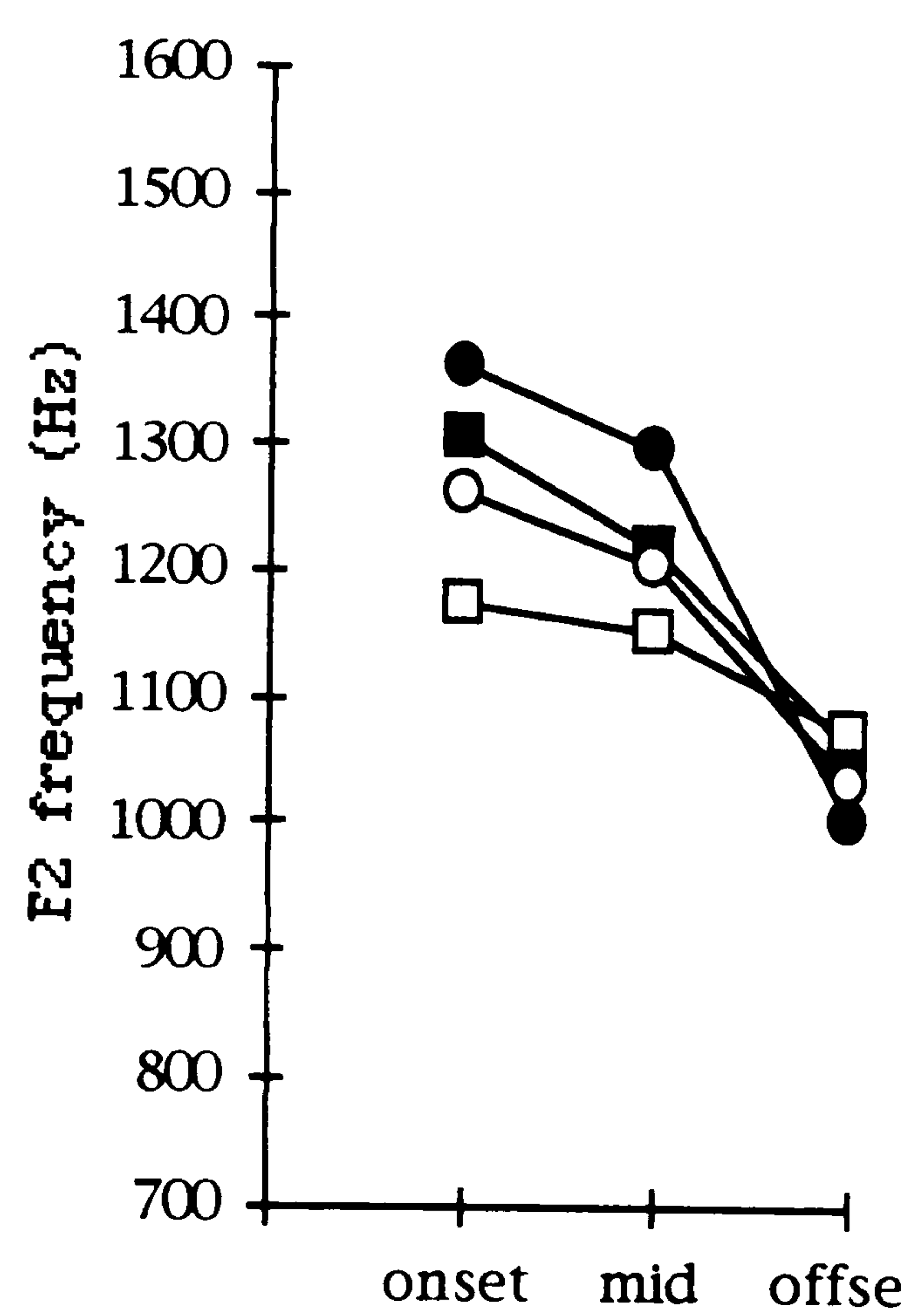
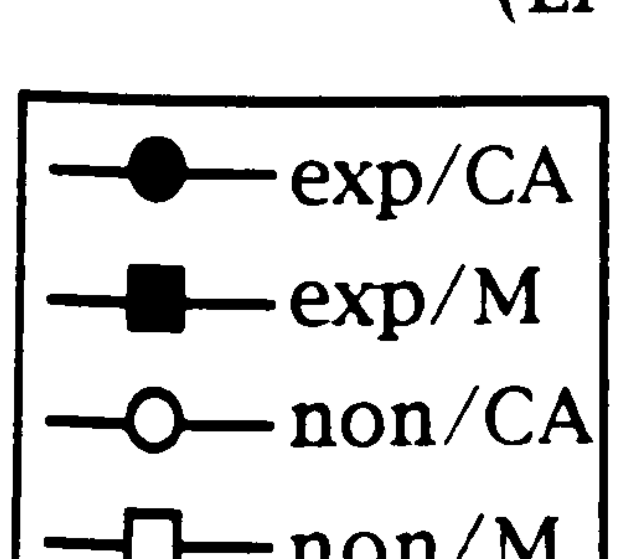


Fig. (59): All speakers/styles (PE context)



4.2.4.3 Comparing the trajectories of the experts and non-experts

The difference between the experts and non-experts and between CA and MSA in contexts involving emphatics arises because *tajwid* recommends that the reciter should produce a large emphatic gesture and avoid emphasis in certain contexts. As indicated above, the E target in the EE context ranges from lowest to highest according to speaker and style as follows:

(i) experts' recitation which is characterized by the most depressed second formant.

(ii) experts' ordinary reading style which has a second formant which is higher than the one in (i).

(iii) non-experts' recitation which shows a higher second formant than the one in (ii).

(iv) non-experts' ordinary reading style which is characterized by the highest second formant among the four categories.

The same finding applies to the EP/PE contexts where the amount of F2 lowering is motivated and directly affected by expertise and style. On the other hand, the PP vowel context reflects no difference between different speakers and styles and it remains neutral. In short, emphasis seems to have a wider range of phonetic implementation than plainness. Speakers can exaggerate emphasis in various ways whereas that is not possible with plainness because there is nothing to exaggerate. There is no empirical evidence in our data that the speakers exaggerate the plainness of the vowel in the plain environments examined. It can be assumed therefore that the phonological contrast between emphasis and plainness is actually made between a marked and unmarked value rather than between two marked or contrasting values (features). In other words, it seems as if the vowel is either marked for emphasis or it is totally unmarked (i.e. neutral) for this feature.

4.2.4.4 Similarity between the members of each category of speakers

ANOVA showed significant differences between experts and non-experts and also between CA and MSA in the treatment of emphatic spreading. But it also showed that the speakers within each group were not consistently different with all the vowel contexts examined. This clearly implies that both similarities and differences between speakers are expected.

The acoustic similarity between speakers could have significant implications. As for the experts, there was a significant main effect for speaker with the exception of the EP vowel context. Similarly, there was a significant main effect for speaker when the EE and PE measurements of the non-experts were tested statistically but they differed as regards the other two contexts. The statistical analysis further showed a significant difference between the PP measurements of the experts although, depending on the conclusions reached so far, a completely plain environment hardly shows a significant variation between speakers. We think that individual differences of voice should be normalized away and, in our case, they might have affected the statistical analysis. This conclusion applies to the PP context as well as to the other contexts. The results of ANOVA were based on measurements that were certainly affected by the shapes of the vocal tracts of different speakers. It might be possible in future studies to eliminate non-linguistic measurements that could affect statistical analyses.

It has become clear that not all the speakers managed to retain the plainness of the vowel in the PE context. By contrast, all of them spread emphasis to the vowel in the EP/EE contexts. All the speakers spread emphasis to the following vowel, but the size of the emphatic gesture differed so that only the good reciters attained the largest emphatic gesture. It also worth noting that the differences among the speakers as regards the emphatic context could be the result of the wide range of emphasis. But the reciter may not find exaggerating the size of the emphatic gesture as difficult as avoiding the effect of the upcoming emphatic consonant on the vowel that precedes it in CVC strings.

4.2.4.5 Correlation between expertise and speakers' distinction between styles

It was shown that some speakers, whether experts or non-experts, showed some significant differences between CA and MSA. This implicitly reflects their appreciation of *tajwid*, otherwise the measurements would be similar for both styles. However, there is no simple and straightforward correlation between speaker's expertise and the extent to which CA and MSA are differentiated in the oral performance of Arabic. In other words, if the speaker makes a small difference between the two styles that does not necessarily imply that he has a good expertise in recitation. For example, a non-expert may confuse the two styles and makes CA passages similar to those of MSA. He is definitely different from an expert who would rather make MSA similar to CA.That leads to the question of how far can recitation affect ordinary reading style and interfere with it? An expert (e.g. E6) may adhere to *tajwid* when he is reading MSA texts. By doing so he is probably idealizing his pronunciation all the way through. But there is some controversy in the traditional literature as to whether *tajwid* is to be used with all texts or it is merely reserved to CA.

4.2.5 Evaluation the non-experts' recitation and its relevance to acoustic findings

4.2.5.1 The experts' ranking of the non-experts

One of our goals in the present study was to investigate the objective basis for 'expert reciter' status in tradition. It was decided therefore that the subjective grading/ranking of the non-experts might also help us identify the objective basis for 'expert reciter' status. Since an expert reciter is usually considered an authority of recitation the experts recorded were requested to evaluate the oral performance of the non-experts. Our aim was to see whether there existed some correlation between the grades given to the non-experts and acoustic measurements of the non-experts' speech. The grading did not cover the experts themselves. Experts reciters are not as many as non-experts, and some of them may happen to know each other specially if they are living in the same community or come from the same country. Our experts were no exception and they knew each other. This made it both awkward and methodologically inappropriate to have the experts grade each other.

The grading of the non-experts was based on a ten-point scale where 10 was designated for the best performance. A special evaluation sheet was prepared for this purpose and it included a list of basic rules including emphasis. Each expert made his grading independently and was left free to listen to the portions he selected from the recordings of the non-experts. Although the experts were provided with lists of rules they did not always refer to them. In fact, some experts added further rules and/or comments. Each expert took roughly 30-50 minutes to complete the grading. In order to get as objective a grading as possible the names of the speakers remained confidential and the experts were not told about the dialects, educational and social backgrounds of the non-experts.

The grades are presented in Table (20) below. E3 is not included because he was not able to participate in the grading). N2 got the lowest average grade (3) while N9 got the highest (9.2). The first four speakers seem to have similar recitation abilities because their grades are similar. There is a general agreement among the experts on the ranking of the non-experts although the experts were not together when they did the grading. In fact, no expert came to know the grades the other experts gave to any of the non-experts.

Spearman Rank Correlation Coefficient was conducted to measure the correlation between the grades the experts gave to the non-experts. The objective was to see whether the experts ranked the non-experts similarly or not. Because there were more than two independent variables (in this case the variables were the experts who did the ranking) the test measured the difference between the grades given by each expert with the ones given by every other expert, e.g. E1 and E2, E1 and E3, E1 and E5, E1 and E6, and so forth.

It was found that the grades correlated positively. Speakers who were given low grades by one expert were also given low grades by the other experts, and speakers who were given high grades by one expert were also given high grades by the other experts. There was no contradiction in the grading although some experts were 'stricter' in the sense that they gave lower grades than others. For example, E6 gave N9 7 points whereas the other experts gave him 9-10 points.

Speaker	E1	E2	E4	E5	E6	Av. Grade
N1	5	3	6	6	5	5
N2	3	2	3	4	3	3
N3	3	3	5	5	5	4.2
N4	4	3	5	6	5	4.6
N5	6	5	8	8	7	6.8
N6	8	7	8	9	6	7.6
N7	8	6	9	8	7	7.6
N8	8	6	9	7	7	7.4
N9	9	10	10	10	7	9.2

Table (20): The ranking of the non-experts

Thus, high scores (grades) on one variable corresponded to high scores on all the other variables. For example, all the experts gave N1 the lowest score, preferred N5 to N1, and gave N9 the highest score among all the non-experts. The result of the correlation test below in Table (21) implies that there is a strong correlation between the ranking order of the experts. The scores given by each expert on the horizontal axis were compared with the scores given by every other expert on the vertical axis. The first value in each cell stands for 'r' (correlation coefficient). The closer the value to 1.0 the stronger the correlation. The second value in each cell expresses the significance.[26]

E2	0.957 P .000			
E4	0.961 P .000	0.913 P .000		
E5	0.928 P .000	0.949 P .000	0.639 P .001	
E6	0.851 P .002	0.824 P .003	0.930 P .000	0.814 P .004
	E1	E2	E4	E5

Table (21): Correlation coefficient of the experts' ranking of the non-experts

4.2.5.2 Correlation between grades and acoustic measurements

The experts agreed about the ranking of the non-experts; do they agree with some objective measurements? There might be a correlation between the grades given to the non-experts and one or both of the following:

(i) ΔF2 in EP/PE trajectories as well as the difference between the mean values of PP-EE trajectories.

[26] The strength of correlation coefficient depends on its value. According to Rowntree (1981: 170) the following values are proposed:

0.0 to 0.2 very weak/negligible
0.2 to 0.4 weak/low
0.4 to 0.7 moderate
0.7 to 0.9 strong/high/marked
0.9 to 1.0 very strong/very high

(ii) 'A' value (asymmetry) which refers to the overall difference between the beginning and end of the vowel trajectories in EP and PE context.

We will briefly describe the assumptions raised above.

(i) ΔF2 in EP/PE trajectories and PP-EE differences values

In the previous discussions we adopted the hypothesis that ΔF2 could be directly relevant to expertise and style because its size is generally larger for the experts/CA. ANOVA also showed there was a significant difference between the experts and non-experts in both contexts. The PP/EE trajectories were quantified differently by computing the mean values of the vowel's onset, mid and offset and it was found that the experts differed significantly from the non-experts.

The values representing ΔF2 (EP/PE contexts) and the PP-EE mean difference are presented in Tables (22), (23) and (24) below along with the average grades of the non-experts. The data is arranged according to the grades from the lowest to the highest. It is expected there is a correlation of some degree between the grades and the speakers' measurements because the increase of the former is generally accompanied by the increase of the latter.

Speaker	Average Grade	ΔF2
N2	3	106
N3	4.2	210
N4	4.6	94
N1	5	245
N5	6.8	251
N8	7.4	269
N6	7.6	363
N7	7.6	366
N9	9.2	357

Table (22): Grades and EP ΔF2 values

Speaker	Average Grade	ΔF2
N2	3	41
N3	4.2	123
N4	4.6	98
N1	5	188
N5	6.8	233
N8	7.4	301
N7	7.6	357
N6	7.6	409
N9	9.2	287

Table (23): Grades and PE ΔF2 values

Speaker	Average Grade	PP-EE diff.
N2	3	302
N3	4.2	338
N4	4.6	339
N1	5	444
N5	6.8	484
N8	7.4	464
N7	7.6	366
N6	7.6	527
N9	9.2	510

Table (24): Grades and PP-EE difference

A correlation test was thus carried out to examine our expectations. It showed that there is a strong correlation between the grades of the non-experts and the ΔF2 of EP/PE trajectories as well as the PP-EE difference values. The result is indicated in Table (25). 'R' stands for the correlation coefficient value and 'P' for chance probability.

Correlates	R	P
EP ΔF2	.875	.002
PE ΔF2	.878	.002
PP-EE diff.	.887	.001

Table (25): Correlation between grades and the amount of change in F2

(ii) The asymmetry

It was proposed above that the overall asymmetry between the beginnings and ends of the vowels in the EP and PE trajectories could have a direct correlation with the expertise of the speaker. Table (26) presents the average grades of the non-experts and the mean values of 'A'. The speakers are arranged according to their grades from the lowest to the highest. Generally, the more 'A' approaches +1 the higher the grade.

Speaker	Average Grade	'A'
N2	3	-0.8
N3	4.2	-0.42
N4	4.6	-4,42
N1	5	0.17
N5	6.8	0.55
N8	7.4	0.52
N6	7.6	0.38
N7	7.6	0.38
N9	9.2	0.03

Table (26): Grades and values of 'A'

A correlation test was thus carried out. It showed that the sharpness of the elbow has a weak correlation with the grades as indicated in Table (27) below. This either means that (i) there may be a better way of quantifying the difference between the asymmetrical patterns of the trajectories, or (ii) the difference between the values of 'A' is not as important to the experts' ratings as the gradient increase in emphasis which the other measurements indicate. But the 'A' values clearly identify two groups of non-experts: a good group and a poor group. These are N5, N6, N7 and N8 as opposed to N1, N2, N3 and N4. There is something odd about N9 although his ΔF2 and his PP-EE difference scores clearly rank him with the good reciters. But this is yet another indication that this 'A' parameter may not be quite right. It is also quite possible that the correlation between 'A' values and the non-experts' scores was not found significant because the 'A' value exhibited by N9 in addition to those of the non-experts who were more like the experts. In general, however, it could be argued that the extent to which F2 is lowered is more crucial to the acoustic and statistical analysis of emphasis than other parameters such as the asymmetry in our experiment. This observation is consistent with the strong correlation between EP/PE ΔF2 as well as PP-EE difference values, on the one hand, and the experts' ratings of the non-experts, on the other.

Correlate	R	P
PE 'A'	.495	.176

Table (27): Correlation between grades and values of 'A'

4.2.5.3 Comments on the experts' ratings

As regards the experts' rating of the non-experts, it has become clear that there is a subjective norm which the former are capable of internalizing. It was seen that the experts independently rated the non-experts as much the same way. Because the norm is itself subjective we cannot necessarily say clearly what it is. But it was shown that at the very least one of the parameters the ratings correlated with was the amount by which the non-experts depressed the second formant of the vowel in emphatic context. The ratings were based on a variety of *tajwid* rules and not only emphasis. Obviously, it is quite possible for a non-expert to be better at emphasis and worse at some other aspects of recitation, or the other way round. But the crucial point to emphasize is that there is a clear objective correlate of the experts' subjective ratings and there is further a clear agreement between those ratings. Therefore, the experts make their judgements on some basis that allows them to be consistent. The combination of the fact that the ratings correlated significantly with each other and the correlation between the ratings and the amount of F2 depression shows that we are dealing with a methodology that is at least potentially objectively specifiable and that the degree of F2 depression in emphasis is one of the things that are essential to standard recitation practice.

4.2.6 Summary

The traditional distinction between expert and non-expert reciters and between CA and MSA apparently has an objective basis. The acoustic measurements of /a/ in a variety of contexts that involved a number of emphatic and plain consonants showed that emphasis is not treated the same way by all speakers. It is true that emphatic spreading is shared by both the experts and non-experts possibly because of the nature of the emphatic gesture which tends to affect adjacent segments and colour them with its properties. But *tajwid* also places restrictions on the direction of the spreading which must be unidirectional and it makes CA utterances constantly characterized by a larger emphatic gesture than those of MSA. We found no evidence that the two requirements were met by the non-experts who had poor reading abilities. The statistical analysis further showed that there were significant differences between the experts/CA and non-experts/MSA in the treatment of emphatic assimilation.

We further saw that emphasis is a continuum: the stronger emphasis the reciter produces the lower the second formant could be. A strongly depressed F2 that closes together with F1 is the normal acoustic output of an exaggerated emphatic gesture which is produced by an expert reciter. Accordingly, it could be assumed that the emphatic continuum offers reciters with a wide range of options so that they could colour the vowel with different degrees of emphasis depending on the rules involved and possibly some other factors. By contrast, the range of plainness is so limited that we could hardly find differences between speakers and styles. In other words, emphasis is more crucial to expertise and style than plainness. Plainness is the base line or the zero/neutral value from which speakers depart. There was no empirical evidence that plainness is affected by the expertise of the reciter. This finding has significant implications for phonological theory as it will be indicated in the following chapter because it implies that emphasis is likely to be unary. That clearly contradicts the assumption raised by *tajwid* scholars that emphasis is a binary feature.

Tajwid rules state that emphasis is supposed to spread/colour the following vowel but not the preceding vowel. That could have given rise to the acoustic asymmetry we saw between the beginning and end of the vowels in the EP and PE contexts. Although F2 is lowered in both environments the middle frequency value is consistently more like the initial value in the PE context. That is, it remains as high as possible before it gets lowered. That points to divergence from the midpoint so that most of the change would happen during the production of the second half of the vowel. The asymmetry between the vowels before and after the intervening emphatic consonant in CVC strings could have the indication that only perseverative emphatic assimilation is used in ideal recitation. The phenomenon of the asymmetry and the finding that the experts' recitations are consistently characterized by the highest P target in the PE context has the implication that emphatic coarticulation is being resisted as to produce a plain vowel in an emphatic environment. But it was also pointed out that the asymmetry is not probably the only evidence for coarticulation resistance because the experts could also maintain the highest P value in the PE trajectories.

The question of whether there is an objective basis for the distinction between experts/CA and non-experts/MSA was further addressed by investigating the correlation between the different acoustic measurements and the grades given to the non-experts by the experts. Statistical analyses showed that the grades correlated significantly with the measurements and that the experts' evaluation was consistent. That shows that the *tajwid* scholars are objective with their classification of speakers into experts and non-experts. The experts' ratings were based on all the rules presented in this study including emphasis. Nevertheless, the ratings correlated with the acoustic measurements and showed that experts evaluated others' performance using some sort of internalized subjective norms which are not quite clear to us because they are primarily subjective. But these norms demonstrate that the experts are dealing with criteria that are at least potentially objectively speciable.

The experimental findings so far reported will hopefully allow us to shed some light on a number of issues that are presently of great concern to phonologists and phoneticians. The discussion in the following chapter will focus on the implications of the acoustic findings for emphatic assimilation in CA whether as a linguistic phenomenon or as mechanical and gradient. The acoustic findings may contribute to our understanding of the phonology-phonetics interface in current theories of language. Emphasis will thus be dealt with within the framework of modern theories that address the relationship between the two disciplines and assess accordingly the status of the phonetics in linguistic theory.

CHAPTER FIVE
THEORETICAL IMPLICATIONS OF ACOUSTIC FINDINGS

5.1 Introduction

A number of phonological processes attested in different languages such as vowel harmony, nasalization, deletion of segments and, in our study, emphatic assimililation can be accounted for by the adoption of autosegmental representation of featural spreading and blocking. The chief problem in the description of emphatic assimilation, as reported by Hoberman (1989), is to predict the extent of the span through which emphasis spreads from one segment to adjacent segments, very often beyond the original syllable that contains the emphatic consonant and occasionally across word-boundaries. The domain of emphasis can be the single segment, the syllable, the word or even the phrase.

It is generally assumed that the autosegmental treatment of emphasis could offer straigtforward solutions to a number of problems including the wide range of variation which Arabic dialects show in respect of the spreading and blocking of emphasis. Besides, autosegmental studies of emphasis in a number of dialects (e.g. Card 1983, Hoberman 1989, Younes 1993 and Davis 1993) implicitly indicate that emphatic spread may not be considered an aspect of low-level emphatic coarticulation but more properly a phonological rule which is language-specific. If this assumption is valid it will further support the autosegmental analysis of emphasis in Arabic because it tackles the problem of the place of emphatic assimilation in the linguistic grammar and rules out an entirely phonetic interpretation of this phenomenon. Emphatic assimilation could thus be a categorical and abstract rule which lies in the underlying phonological level of the language. That is basically what an autosegmental analyst of emphasis would attempt to demonstrate particularly when he comes to know that emphasis is variable from one dialect to another and that it has a domain over which it can spread.

The empirical findings of this study do not contradict Nelson's statement (1980) that "also unique to Qur'anic pronunciation is that the phenomenon of velarization (emphasis) is only immediately progressive. In other words, the influence of a velarized phoneme does not extend to the whole lexeme, but affects the phoneme and its vowel" (p.48). This is the *tajwid* claim that in a CVC̣V string only the vowel following the emphatic consonant should be coloured with emphasis whereas the vowel preceding the emphatic consonant must remain plain particularly because it is preceded by a plain consonant. In other words, emphasis spreading in CA is unidirectional and perseverative. The feature to be associated with the vowel is the feature associated with the preceding consonant. Also, the maximum domain of the spreading is the string C̣V (or C̣VV) but not strings like C̣VCC, C̣VCVC, CVC̣C or CVC̣VVCVC. For example, in *ṣawt* 'voice' emphasis is bound to the C̣V string. In *ghalab* 'he defeated' the second syllable is required to remain plain even though the first syllable contains an emphatic consonant. In *faṣl* 'separation' the domain of emphasis is locked to the /ṣ/ and no spreading should occur in either direction. The lateral should remain plain (light) on the basis that only post-emphatic vowels can exhibit emphasis but not consonnants. Finally, in *aḍā'at* 'it lightened' where the utterance contains three vowels the spreading is perseverative and, at the same time, it does not extend beyond the boundaries of the emphatic syllable. Although our experiment did not cover more than three segments in each test token we could indirectly provide some evidence that these claims are true. While we did not investigate the treatment of emphatic spreading over several syllables in individual words there was not much of a difference between, for example, a plain CV syllable which is embedded between two emphatic syllables (C̣VCVC̣V) and a plain syllable occurring in a string like CVC.

Let us now consider the autosegmental analysis of emphasis offered by some phonologists in the course of their discussion of emphatic spreading in some regional dialects of Arabic. The main line of argument is that emphasis can be treated like a tonal feature that spreads categorically from a trigger to a target segment over a sequence of adjacent segments which are not marked for [+emph]. The spreading usually proceeds in both directions to affect both pre-emphatic and post-emphatic segments. A number of phonologist (e.g. Card 1983 and Younes 1993) claim that in certain dialects the spreading could even cover the whole utterance. The only factor that can prevent the spread of emphasis is the existence of emphasis blockers (Younes 1993). But we should recall that the autosegmental analyses of emphasis in Arabic which have been considered in the literature review above give a different account of the meaning of feature blocking as originally proposed in Goldsmith (1976) and developed in Clements (1976). According to the autosegmental approach blocking is abstract. It results because there exists a segment which carries a feature that contrasts underlyingly with the feature carried by the trigger assimilating segment. The existence of two contrasting features on the same tier results in the blocking. The studies we reviewed, however, treat blocking as a mechanical process which is dictated by the articulators. A segment would thus resist the spreading of emphasis if it involves articulatory movements which are contradictory to that of emphatic articulation. In the course of the following discussion we are going to see which approach is more appropriate to account for the blocking of emphasis in the styles examined, the abstract or the concrete. At present, this point is not clear.

Consider, for example, the preliminary autosegmental representations in Fig. (60) below. They schematize the spreading of emphasis as it is carried out by an expert and a non-expert reciter. The utterances illustrated are: (i) *ṭaghā* (C̣VC̣VV) '(he) exceeded the bounds', (ii) *biḍanīn* (CVC̣VCVVC) 'withhold grudgingly', and (iii) *ṭabaq* (C̣VCVC) 'stage/layer'. The difference between the two speakers as far as CA is concerned is that the expert uses unidirectional (perseverative) spreading which is bounded to the syllable that contains the emphatic consonant whereas the non-expert tends to generalize the spreading, possibly to cover the entire utterance.

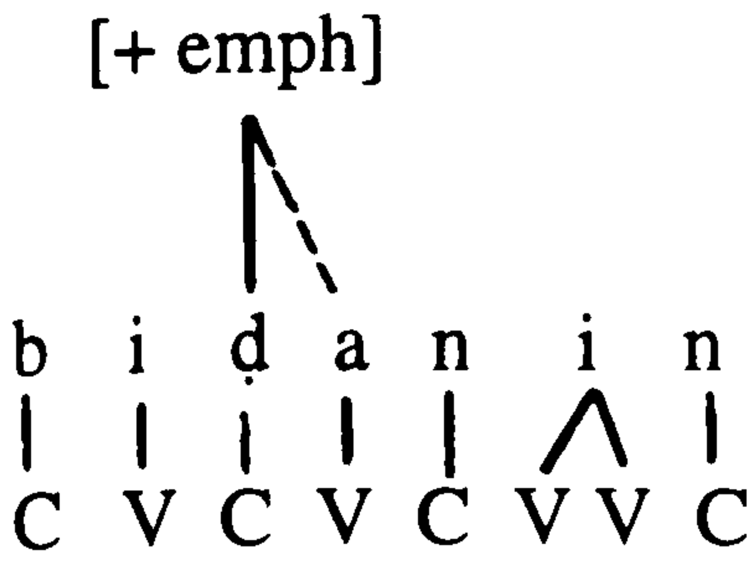
(a)

Expert (CA) Non-expert (CA)

[ṭaʁa:] [ṭaʁa:]

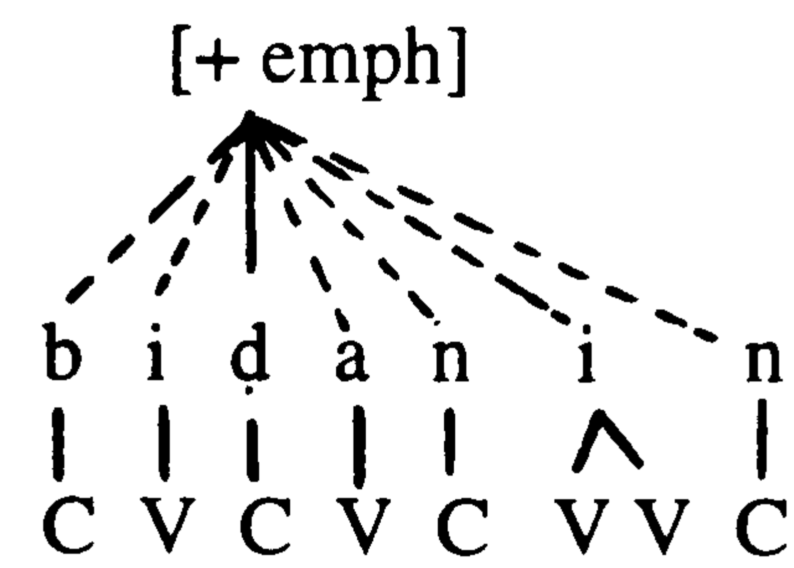
(b)

Expert (CA)



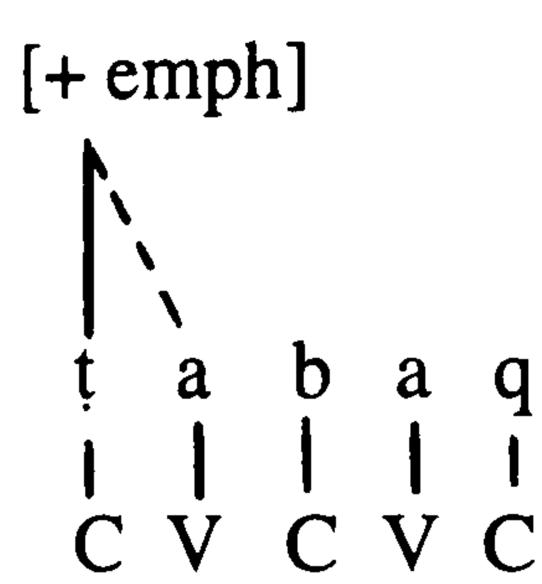
[biḍani:n]

Non-expert (CA)

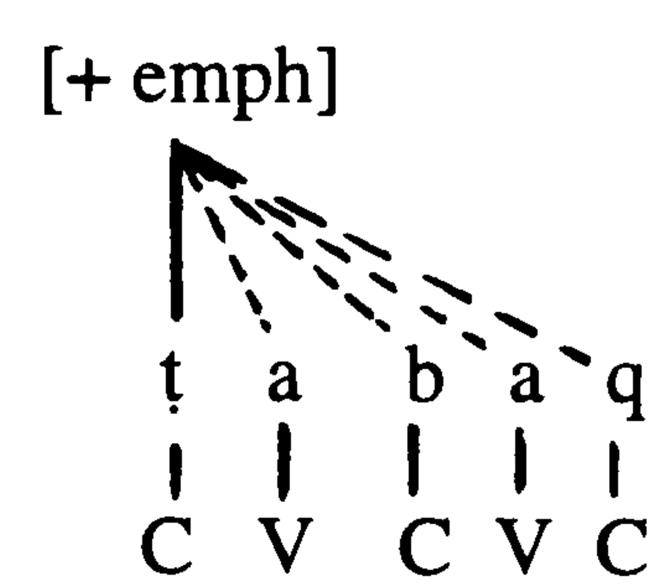


[biḍani:n]

(c)



[ṭabaq]



[ṭabaq]

Fig. (60): Preliminary autosegmental representations of emphatic spread in CA (expert vs. non-expert)

As stated above, there is a general tendency among phonologists (e.g. van der Hulst 1985, Hoberman 1989, and Kenstowicz 1994) towards the adoption of the view that the autosegmental approach is preferable to a segmental model such as *SPE*. As was stated earlier, the use of autosegmental representations was extended to account for phenomena other than the spreading of tones such as vowel harmony, nasalization and emphasis. It is generally assumed that the autosegmental approach leads to significant predictions about assimilation in any language. The advocates of the autosegmental approach claim that primitive units such as tiers and association lines permit the expression of a richer variety of arrangements of distinctive features than is possible under the traditional linear approach (including perhaps the one of *tajwid*). El-Dalee (1984) further states that the unit of the syllable can be accommodated in the autosegmental and metrical approaches but it is neglected under the segmental approach. Hoberman (1989: 76) further assumes that the autosegmental notation makes it possible to indicate which segments are part of which morphemes without the use of quasi-segmental morpheme boundaries. These comments give support to the view which explicitly discards the traditional segmental approach to phonological analysis in favour of the autosegmental approach. Now, we do not wish to compare the segmental and autosegmental analyses as done, for example, by van der Hulst (1985) in his treatment of vowel harmony in Hungarian. He analyzes this phenomenon using the two different approaches and concludes that the autosegmental approach has a priority over the other. His comment is that "it allows us to be concrete and disallows many of the abstract analyses that are possible in an *SPE* type of approach" (p.300). It should be noted that comparing the two approaches is beyond the scope of the present study. In addition, our use of autosegmental representations of emphatic spreading/blocking does not necessarily entail that other representations of exactly the same kind of phenomenon would be deficient or inadequate. We have decided to adopt the autosegmental approach mainly because it offers practical solutions to the problem of emphatic assimilation not only in CA or MSA but probably in other styles of Arabic as well.

It is still not clear how to account for the blocking of emphasis. There exists empirical evidence that emphasis is not a binary feature as proposed in *tajwid.* The autosegmental models that have been proposed so far (e.g. Card 1983 and Younes 1993) did not tackle this problem properly. Featural blocking in these models is not exactly the same as the one in the original autosegmental theory. It is a phonetic blocking which is imposed by articulatory factors and, therefore, it may not be attributed to the abstract level. This sort of modification to the autosegmental approach could lead to difficulties, especially when we want to make predictions about when emphasis is supposed to spread in a particular context or style and when it is supposed to be blocked. However, in spite of the nature of this kind of problem in those models they still adopt the hypothesis that there exists an underlying categorical rule which spreads emphasis from a trigger to a target segment. In other words, it is mainly a question of how accurate or reliable the models are. They do not contradict the notion that features spread categorically from one segment to another.

The second kind of problem is somewhat more radical from the phonological point of view. Some researchers do not adopt the hypothesis that certain features spread categorically from one segment to another. This is the general line of argument raised by some phonologists (e.g. Cohn 1993 and Keating 1988 and 1990) who are interested in the relationship between phonology and phonetics, a phenomenon which is not accounted for under the *SPE* approach. Cohn and Keating argue that surface underspecification may persist into the phonetics so that a segment which is underlyingly unmarked for a given feature can remain unmarked for that feature on the surface. Thus, they could bridge the gap between phonetics and phonology. Their evidence for the persistence of the underspecification to the phonetics is normally the gradualness of the phonetic properties of the underspecified segments. In the *SPE* version of generative phonology, on the other hand, a clear distinction is drawn between phonology and phonetics. It is assumed that surface underspecification never exist in the phonetics because all segments must end up fully specified for their features. The overall picture of *SPE* and subsequent works thus shows that phonology is regarded as a branch of linguistics on the basis that it is language-specific and categorical while phonetics is independent of the linguistic grammar because it is universal and mechanical. The difference between phonology and phonetics is one between a symbolic and timeless psychological representation and a physical and continuous representation that can be realized temporally and spatially. As Pierrehumbert and Beckman (1988) put it, "treating the phonetic component as universal and extragrammatical tended to divorce the study of phonetics from the study of phonology" (p. 3). This anti-*SPE* view, which is further adopted by a number of phonologists including Keating (1988) and Cohn (1990), has the advantage of bringing back the phonetics (or probably part of it) into the domain of the linguistic grammar after it has been excluded for several decades since the 1980's. We will address these issues in this chapter and attempt to decide whether emphatic spreading in CA and MSA is language-specific or mechanical. Our discussion will refer to the acoustic findings reported in the preceding chapter

5.2 Phonetic (surface) underspecification

The question of whether redundant features should be included in formal representations of languages has been subject to dispute since the 1960's and may still have no clear answer. In general, there has been a tendency to eliminate redundant features and condense the number of distinctive features to the extreme minimum limit possible. However, the ruling out of redundant features from the phonology may not always be a good idea even though it is pretty consistent with the principle of economy which generally characterizes the distinctive features framework. For example, Anderson (1985) states that it quite possible that two or more properties, each of which is predictable in terms of its environment, are interrelated so that they cannot be eliminated simultaneously. "In such a case, we must conclude that a minimally redundant representation is not really to be desired" (p.10). But it is worth noting that Anderson does not mean that redundant features should be included in formal representations instead of being excluded and introduced later by additional rules. He merely means that the elimination of any single feature (and generally the adoption of all features) should be studied carefully. That is, we should not be very much moved by the principle that only non-redundant features should be left in the phonology. In some contexts or styles it is quite possible that a redundant feature takes on a distinctive function.

The redundancy of features in the *SPE* model does not persist into the phonetics. Although certain segments are not fully specified for certain features in the underlying form all the segments in a given utterance must end up fully specified on the surface. Underspecification thus remains a phonological problem. Phonological feature fill-in rules are applied to ensure that each segment is fully specified for a set of features in the phonetic output. According to Stevens *et al* (1986) and Keating (1988), it is possible to classify these rules into three categories. The first category comprises rules that fill in feature values without reference to context. They may be called *fill-in rules*. For example, a fill-in rule may introduce the feature value [+ voice] for sonorants, or if only [+ voice] is underlying it may introduce [-voice] for any segment lacking a value for this particular feature. The second category comprises *position rules*. These fill in feature values on the basis of a segment's position in a string of segments, syllable structure or the like, but without reference to neighbouring segments. For example, the feature value [+spread glottis] may enhance [-voice] in initial position (Keating 1988: 277). The third category comprises *context rules*. They fill in feature values on the basis of the features assigned to adjacent segments. Context rules cover assimilation, dissimilation and vowel harmony. A good example is the treatment of emphasis in Arabic which is the core of our discussion. Vowels adjacent to emphatics (more specifically the low vowel /a/) are predictably emphatic because of context. They are underspecified for [+ emph] in their input forms but they end up fully specified for this feature because of the influence of the neighbouring emphatic consonant. Similarly, English vowels are not underlyingly marked for [+ nasal]. But they exhibit this feature when they occur in the vicinity of nasal stops as in *man* [mæ̃n]. Thus, vowels end up fully specified for nasality in the phonetic output.

The above assumptions about full feature specification on the surface have been questioned by some phonologists particularly those interested in the phonology-phonetics interface. The division between the phonetics as the mechanical/universal processes which are common to the speakers of all languages and the rule-governed phonological behaviour which is language-specific rules out the possibility that some of the phonetics could also be part of the grammar. Pierrehumbert and Beckman (1988), Keating (1988 and 1990) and Cohn (1990 and 1993), possibly among others, argue that underspecification could surface and be realized in the phonetics. That is, segments which are not marked for certain features in the phonology could remain unmarked for the same features in the phonetics.

5.2.1 Review of various proposals and models

The interest in surface underspecification is not new. As Keating points out in her review article (1988) a number of phonetic models and attempts dealt with the same basic problem beginning in the 1960's. For example, among the works that addressed the distinction between specified and underspecified articulation in the 1960's are Kozhevnikov and Chistovich (1965), Henke (1966) and Öhman (1966). Kozhevnikov and Chistovich argue that lip rounding in Russian begins at the onset of the syllable. According to them, a syllable consists of a vowel and any number of preceding consonants. Segments coarticulate within but not across the syllable. In other words, the articulatory domain of coarticulation is the syllable. They theorize that anticipatory labial coarticulation is promoted by motor commands to the appropriate muscles so that the segments involved will be coproduced. Under their model, coarticulation would not be possible if segments have contradictory (conflicting) articulatory specifications. So, the consonants preceding the rounded vowel would remain underspecified for labial rounding. Daniloff and Hammarberg (1973) similarly mention a group of articulatory activities which are attested in a number of languages such pre-vocalic lip protrusion, jaw opening for an anticipating open vowel and velopharyngeal opening in advance of a nasal consonant. They further expect the existence of other processes that involve all articulators so that the transitions between segments would be smoothed out and minimized wherever possible.

In Henke's computer model (1966) segments do not necessarily have complete targets for particular articulators. Henke adopts the concept of 'look-ahead' scanning mechanism for anticipatory coarticulation of English stop + vowel sequences. Under this model, as soon as a stop contact is made the stop looks ahead to the vowel's targets for other articulators. Kondo (1995) argues that this is basically a feature spreading model so that if the vowel is specified for [+ round], for example, all the preceding segments that are unspecified for this particular feature will be consequently assigned for [+ round]. The spreading of features is blocked only by a specified feature. Both the spreading and blocking are promoted by coarticulatory rules (Farnetani 1997).

Öhman (1966) assumes that segments are not specified for all articulators which implies that he adopts the assumptions raised above. He studied what he describes as "very lawful rules that describe how voiced stops are coarticulated with vowels in vowel-consonant-vowel (VCV) context" (p.151). But his model is significantly different from the models presented above in the sense that vowels and consonants are produced by independent articulators which he calls channels of articulation. For example, he assumes that apical and dorsal constriction systems of the tongue can be controlled independently of vowel activity. According to him, such a distinction between the two articulatory systems is "analogous to the statement that nasalization and voicing are independent parameters in speech" (p. 166). Following the same line of argument, Öhman distinguishes two physiologically independent types of labial activity: (i) the closing motions that take place in the vertical dimension (e.g. English /p, m, v/), and (ii) the rounding-spreading dimension of motion which is used for vowel rounding. He further proposes that English has both rounded and unrounded labial consonants (e.g. /p/ in *put* and *pink*). Accordingly, the vowel component of the total labial system may ideally be used to add phonemic distinctions (but, of course, not to English) to labial consonants that are otherwise produced by (i) above. In other words, the activity of the lips can be similar to that of the tongue in this respect.

Like Keating, we can assume that although Öhman (1966) is describing VCV coarticulation in terms of independent articulators rather than phonological features his distinction is parallel to the notion that consonants and vowels are specified for different sets of features. When segments occur in VCV strings the vowels interact through the consonant which is not specified for the features of the vowels. The effect of the first vowel could thus extend to the onset of the second vowel and the effect of the second vowel could similarly extend to the offset of the first vowel. In other wards, the transition from the first vowel to the second vowel through the consonant in either context is achieved by a single continuous movement. This argument is further supported by Keating (1988) and Kondo (1995). These points are illustrated in Fig. (61) which shows the spectrograms of the Swedish utterances /øgy/ and /øgo/ when spoken by a male native speaker. In both utterances the initial vowel is /ø/ and the intervocalic consonant is /g/ whereas only the final vowel is different. It is observed that F2 in the vowel preceding the stop is rising when the final vowel is /y/ but it is falling if the final vowel is /a/. F3 of the initial vowel is also affected. This implies that the formant transitions are a reflection of the articulatory modification which the initial vowel's offset undergoes under the influence of the second vowel's onset. The effect can thus be traced across the boundaries that separate the second formants of the two vowels.

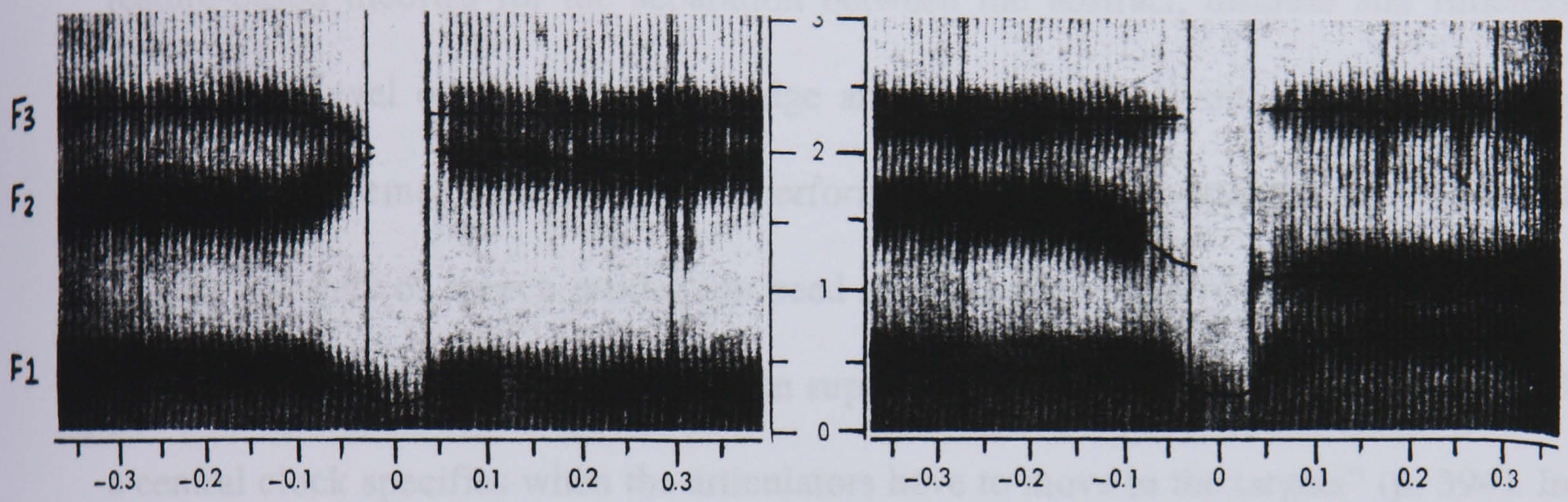


Fig. (61) Spectrograms of the utterances /øgy/ (left) and /øgo/ (right) as spoken by a Swedish native speaker (Öhman 1966)

In the models discussed so far (Kozhevinkov and Chistovich 1965, Henke 1966 and Öhman 1966) the conception of coarticulation is, as Keating (1988) notes, based on gestures or goals rather than phonological features. Coarticulation is the result of articulatory plans such as Henke's 'look-ahead' scanning mechanism. It is carried out to smooth out the transitions between neighbouring segments through the segments that are unspecified for certain articulatory goals. Among the more recent models which seem to have tackled surface underspecification within a different framework is Browman and Goldstein's theory of articulatory phonology (1986 and 1989). It is basically an intrinsic timing or relative time model (Byrd 1994). That is, the phonological primitives or gestures which they develop contain temporal information yielding the duration of the phonological units. Gesture in articulatory phonology may be compared to feature in other models such as *SPE* and autosegmental phonology. One key difference between the former and the latter is the temporal aspect which is crucial to gestural overlap and the coordinated activities of different articulators. A second difference is described by Fowler (1980, cited in Farnetani) who criticizes feature-based theories for the separation between the abstract, discrete and timeless units at the level of language knowledge and the physical, continuous and context-dependent movements at the level of performance. Her basic assumption is that "all current accounts of speech production need a translation process between the abstract and the physical domain: the speech plan supplied the spatial targets to be reached, and a central clock specifies when the articulators have to move to the targets" (p. 394). In other words, gestures are not altered under the influence of adjacent gestures but they rather overlap with each other. Assimilation and other processes can thus be viewed in terms of the temporal overlapping and mutual effects between gestures. The hiding, revealing and blending of gestures result from the extent of gestural overlap. Certain gestures are characterized by increase in overlap whereas others are remarkable for reduction in their magnitude in both time and space.

It should be noted that although articulatory phonology is not a feature-based theory it still resembles autosegmental phonology in some respects. In articulatory phonology gestures can be organized in a hierarchical order according to articulatory independence in a way similar to the organization of phonological features and feature geometries in autosegmental phonology. For example, the tongue tip and tongue body gestures are grouped together under a tongue gesture node since both the tongue tip and tongue body share the tongue body and jaw. At the next higher level, the tongue gesture is grouped with lip gesture so as to constitute a class of oral gestures since both the tongue and lip share the jaw (Lee 1994). Since gestures occur on separate tiers they can overlap (depending on their transparency) so that a gesture on one tier may be hidden by a gesture on the other tier.[27] Consider, for example, the phrase *perfect memory* when spoken in casual speech. Browman and Goldstein (1990) found that /t/ in the first word was produced with an alveolar contact although it could not be heard or seen on the wave form (their finding was based on X-ray microbeam tracings). The alveolar closing gesture for /t/ in *perfect* was thus hidden by the labial closing gesture for /m/ in *memory*. As a result, listeners could not perceive /t/ even though the gesture was present. We can assume that Browman and Goldstein's conception of the sliding of gestures with respect to one another across tiers and the temporal aspect which remains one of their attributes provide representations that contain information about certain articulatory gestures while leaving other information unspecified (Keating 1988). Thus, in the example above (*perfect memory*), and because of the overlap between gestures, the labial gesture overlaps and hides the preceding alveolar gesture which is apparently unspecified for the labial closure.

The distinction between phonological rules of assimilation and phonetic rules of coarticulation can be attested in a group of works such as Daniloff and Hammarberg (1973), Hammarberg (1976), Pierrehumbert and Beckman (1988), Keating (1988 and 1990) and Cohn (1990 and 1993). These studies differ from the previous ones in the

[27] Note that gestural overlap is also possible on the same tier (Kondo 1995). But that could lead gestures to perturb each other because the same articulatory variables are employed but with different targets (Browman and Goldstein 1990). For example, in *ten things* the alveolar closure for /n/ and /θ/ leads to a more fronted articulation of the alveolar closure.

sense that they employ the featural approach rather than articulators or gestures. But they do not necessarily use the same kind of approach, technique or methodology. For example, Cohn (1993) made use of nasal airflow measurements to study nasality in English, French and Sundanese.[28] She based her investigation on raw data as spoken by native speakers. By contrast, although Daniloff and Hammarberg (1973) cite a number empirical studies (e.g. Öhman 1966) they did not themselves rely on experimentation in support of their assumptions. But they all agree that the *SPE* approach is not adequate because it places coarticulation outside the domain of phonology and theorizes that coarticulation processes are supplied by universal rules. This apparently eliminates the possibility that certain phonetic phenomena are language-specific. Daniloff and Hammarberg state that "there remain some context sensitive phenomena which do no involve syntactic conditions, but for which no clear phonological explanation can be found" (p. 241). One typical example they illustrate is vowel duration which is longer before voiced stops than before voiceless stops. They speculate that vowel length could be conditioned by voicing. But they also argue that there exists no plausible casual mechanism which could explicitly account for this phenomenon. It does not seem that a particular feature spreads underlyingly from the consonant to the vowel. Actually, Keating (1990) comments that vowel duration in English is likely to be a systematic phonetic process unlike in some other languages such as Polish and Czech where it is unsystematic or even absent. Accordingly, she speculates that phonetic facts like these should be specified in the grammar. In other words, the long vowel duration before English voiced stops is no more mechanical but it is rather codified by a phonetic rule of coarticulation.

[28] Sundanese is an Austronesian language of Indonesia (Cohn 1993).

The existence of phonological rules of assimilation and phonetic rules of coarticulation is thus very important from the linguistic point of view because they integrate the phonology with the phonetics in some aspects. But this does not, of course, mean that all of the phonetics is grammatical since certain phonetic processes are still to be regarded as mechanical. All it means is that attributing the phonology to the linguistic grammar and all the phonetics to the bio-mechanical demands of the vocal tract is not adequate. The relationship between phonology and phonetics is schematized in Fig. (62) below (taken from Cohn 1993). The figure shows the difference between the *SPE* approach and the one of phonetic underspecification. Note than Cohn calls *SPE* traditional but we prefer to reserve this adjective for *tajwid* in this study to avoid confusion. Having in mind that the linguistic component of any language must contains both phonological and phonetic rules we need to establish a consistent criterion for distinguishing the two categories of language-specific rules. Pierrehumbert and Beckman (1988) provide a helpful clue. They state that "both phonological and phonetic rules seek to describe complex regularities in sound structure through the interaction of a few general principles" (p. 4). They both take as input phonological representations. But the output of phonetic rules is quantitative, representing facts about pronunciation rather than categorical or symbolic representations of sounds. The quantitative or gradient phonetic realization of phonetic rules can be examined experimentally, unlike phonological rules.

(i)	(ii)
SPE view	The phonetic underspecification view
Phonological rules	Phonological rules Language-specific phonetic rules
↓	↓
Universal phonetic implementation rules	Universal phonetic implementation rules
↓	↓
Physiological output	Physiological output

Fig. (62): *SPE* and modern views of the relationship between phonology and phonetics (Cohn 1993)

As a proponent of surface underspecification who assumes that the phonetic realization should not be excluded from the grammar Keating (1990) attempts to formalize coarticulation in the phonetic component as a final stage of derivation in speech production. Her *window* model is basically a model of coarticulation and it is essentially based on the hypothesis that underspecification does persist into phonetic representations. Also, in her model underspecification is not categorical but it is rather gradient and continuous. In other words, Keating does not draw a discrete distinction between 'specified' and 'unspecified'. Instead, she proposes that a segment can be *more* specified or *less* specified for a given feature, and all intermediate degrees are possible. A *window* is thus the range of a given feature value. Specified features are associated with narrow windows and allow for little contextual variation. Unspecified features are associated with wide windows and allow for large contextual variation. Each window has its own duration and width. Windows are connected by paths or contours which interpolate between windows. Fig. (63) is taken from Keating (1990). The effects of narrow vs. wide windows on the interpolation contours can be seen.

The transition from segment 'A' to segment 'C' through segment 'B' is smooth in '2' and '4' whereas it is abrupt in '1' and '3'. The asymmetry between the two transition patterns is the result of phonetic underspecification in the former as opposed to full specification in the latter.

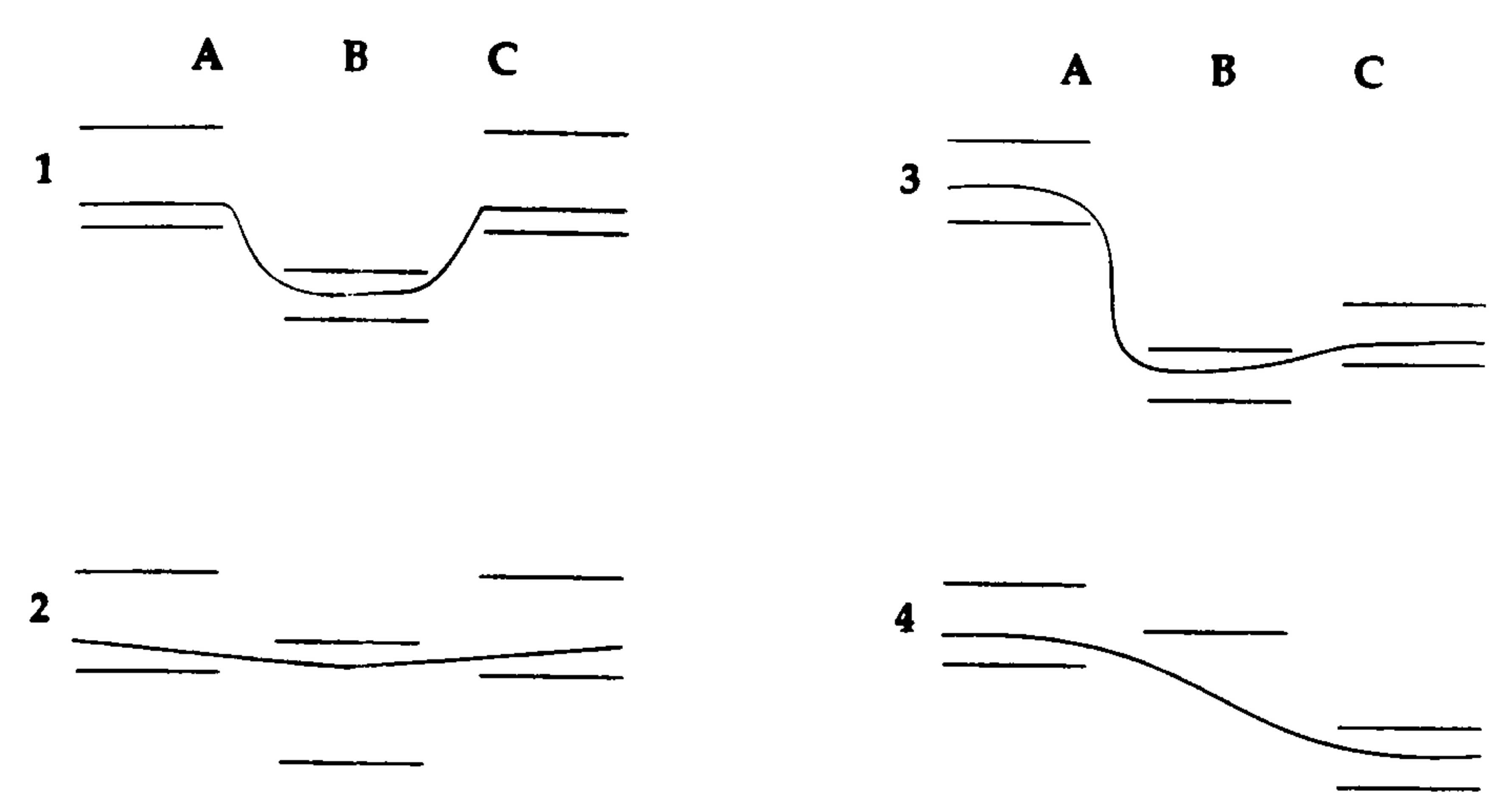


Fig. (63): Illustration of sequences of windows of various width (Keating 1990)

Cohn (1990 and 1993) follows the same line of argument adopted by Keating as regards surface underspecification and she assumes that language-specific phonetic rules do exist. She develops a target-interpolation model where feature specifications leaving the phonology are implemented or translated into phonetic targets, such that a '+' value translates to relatively more of the physical value that implements that feature than a '-' value. The phonetic targets are then joined up through interpolation. Cohn conducted an experimental study where she measured nasal airflow traces in English, French and Sundanese utterances. One of her main purposes was to find out whether anticipatory nasalization in English utterances such as *bean* /bin/ [bĩn] is phonological/categorical or phonetic/gradient. Impressionistically, the speakers of the three languages associate nasality with vowels in a variety of contexts, but French is the only language among the three which contrasts vowels for the feature [nasal]. On the other hand, it is conventionally assumed (particularly in *SPE*) that vowels in English get specified categorically for [+nasal] in the context of nasal consonants. Cohn examined these assumptions experimentally.

Consider Fig. (64) below. Airflow measurements of the French utterance *bonté* /bɔ̃te/ 'goodness' show negligible airflow during the oral stops and the final vowel and significant nasal airflow during most of the duration of /ɔ̃/ which is a nasal vowel. Several repetitions of the same utterance showed consistency across tokens in spite of variation in some of the smaller details. On the other hand, the production of *botte* /bɔt/ 'boot' is characterized by a lack of nasal airflow for most of its duration. This apparently shows a difference between the qualities of the two vowels /ɔ̃/ and /ɔ/. By examining *bonne tête* /bɔnt(ɛt)/ 'good head' it can be observed that the vowel and the preceding oral stop are oral for most of their duration of the nasal consonant. The nasal airflow stops immediately initiating the alveolar closure for the following /t/. Consequently, the transition from /n/ into /t/ is abrupt. In *bon nez* /bɔ̃#n(e)/ 'good nose' it can be seen that the nasal vowel is followed by a nasal consonant. There is significant nasal airflow throughout the duration of both segments. We can observe the rapid transition from /b/ into /ɔ̃/. It is reported by Cohn that the transitions into and out of the nasal segments were very rapid lasting about 20-30 ms.

On the other hand, Sundanese adopts a categorical rule which spreads the feature [+nasal] in a perseverative direction from a nasal consonant until it is blocked by non-nasal supralaryngeal obstruents, liquids or glides. The pattern of the transition from the [+nasal] segment to the [-nasal] segment is also rapid resulting in a categorical output of nasalization as in the word *ɳatur* [ɳatur] ‘arrange’. Consider Fig. (65) below.

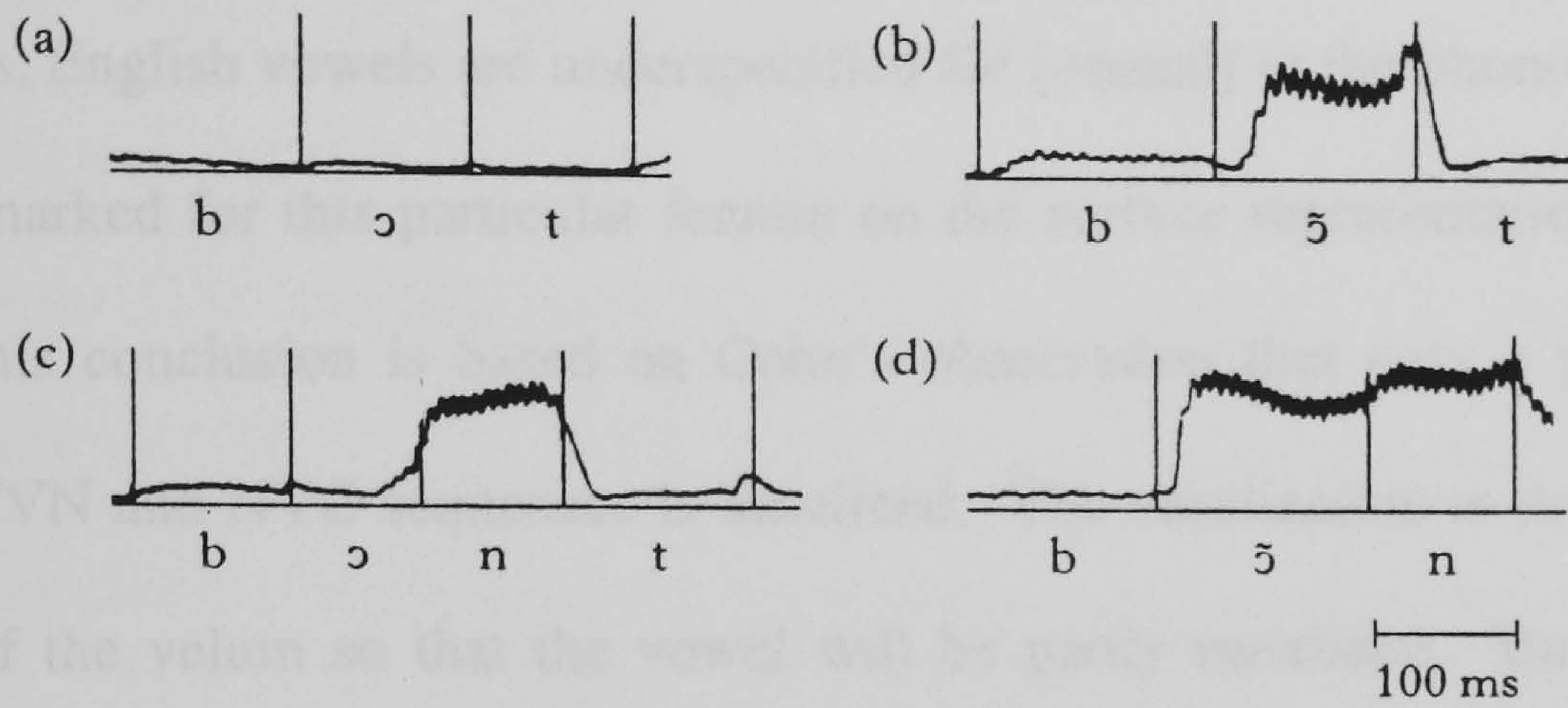


Fig. (64): Nasal airflow traces for nasal and oral segments in four utterances in French (Cohn 1993)

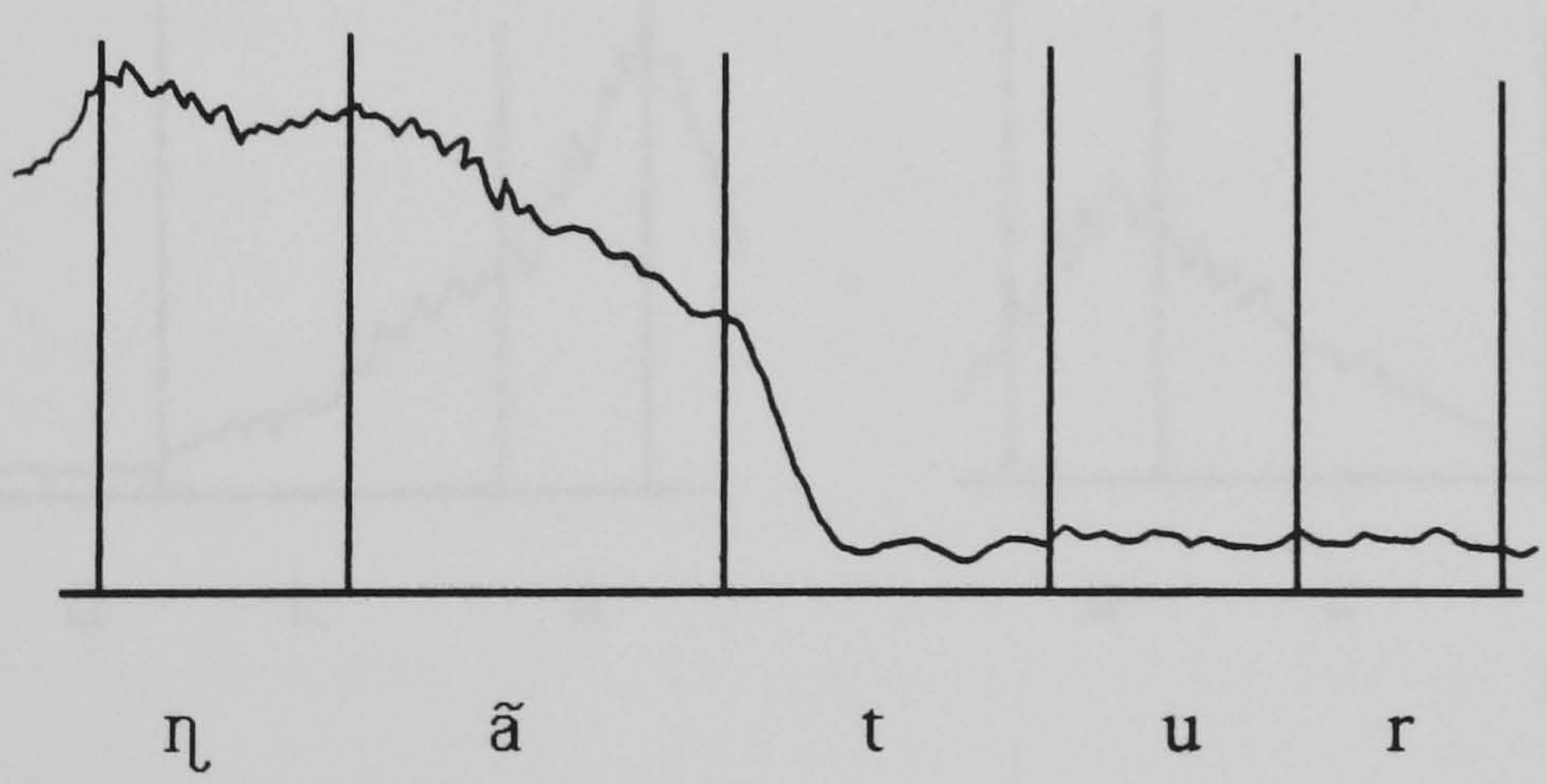


Fig. (65): Nasal airflow traces for nasal and oral segments in *ɳatur* [ɳãtur] ‘arrange’ in Sundanese (Cohn 1993)

Let us now consider the nasal airflow traces for the English utterances *dean* /di:n/ and *need* /ni:d/ in Fig. (66). The transitions into and out of the nasal consonant are gradient/cline-like unlike with French and Sundanese where the transitions are abrupt or plateau as we saw above. Therefore, the patterns shown are the result of phonetic implementation rather than the application of a categorical rule of nasal spread. In the other words, English vowels are underspecified for [+nasal] in the phonology and they remain unmarked for this particular feature on the surface representation or phonetic output. This conclusion is based on Cohn's observation that only a portion of the vowel in CVN and NVC sequences is nasalized. The nasalization is the result of the lowering of the velum so that the vowel will be partly nasalized. But it is not the output of the phonological rule of nasal assimilation as such.

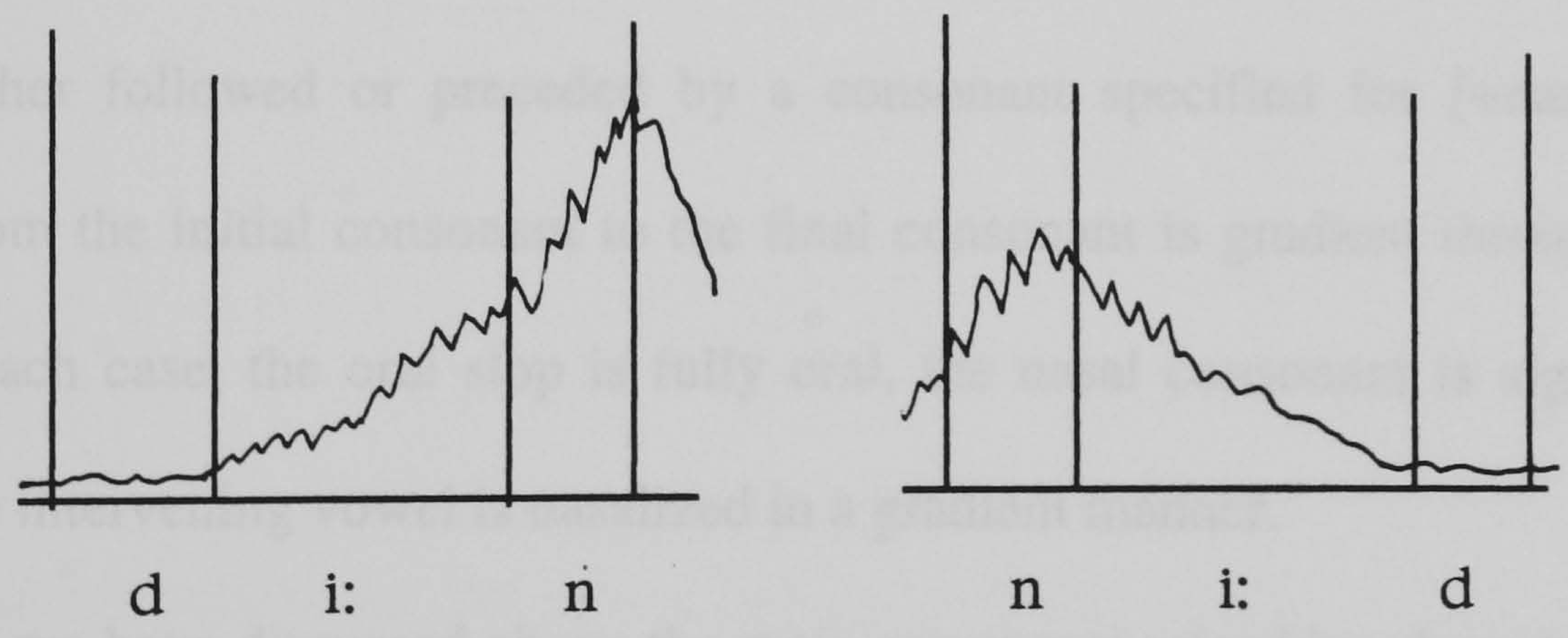


Fig.(66): Nasal airflow traces for VN and NV in English *dean* /di:n/ and *need* /ni:d/ (Cohn 1993)

The difference between a representation of a categorical anticipatory nasal assimilation in English and a phonetic interpolation of nasality through unspecified span for nasality is shown in Fig. (67) below. In (i) each of the three segments is fully specified for [N] ([nasal]) leaving the phonology. Targets are assigned along a scale for the physical dimensions where the [-N] specifications receive low targets, and [+N] specifications receive high targets. These targets are then hooked up through interpolation, showing a rapid transition between low and high targets. In (ii), on the other hand, the C is specified for either [-N] or [+N] leaving the phonology, hence receiving low or high targets, while the intervening V remains unspecified ([∅N]) which means that it actually receives no phonetic target at all. The targets are then connected through interpolation and the intervening V only receives a transitional amount of [+N] from the phonetic context, throughout its duration.[29]

Fig. (68) schematizes the similarity between the phonetic realizations of the vowel in CVN and NVC sequences in English. Cohn considers the effect gradient (non-categorical) in both cases. In both utterances *dean* /di:n/ and *need* /ni:d/ - where the V is either followed or preceded by a consonant specified for [+nasal] - the transition from the initial consonant to the final consonant is gradient throughout the vowel. In each case, the oral stop is fully oral, the nasal consonant is significantly nasal and the intervening vowel is nasalized in a gradient manner.

So far, we have discussed above the main arguments raised by phonologists and phoneticians who have been interested in the problem of feature redundancy and phonological/phonetic underspecification since the 1960's and the comments made by

[29] It should be noted that, according to Cohn (1993), rapid transitions throughout vowels should not be taken as the only criterion for considering nasal spread a categorical rule. She mentions that amplitude

Keating (1988) and others about them. The phonology-phonetics interface has thus arisen as a theoretical issue which derives its origin and evolution from the assumption that feature underspecification can presumably persist into the phonetics. The current distinction between what is phonological/categorical and what phonetic/gradient, is of a great concern to modern theorists of linguistic grammar. In the next section we will attempt to make predictions and discuss some problems about emphasis in CA and MSA depending on our empirical findings. More specifically, we will attempt to find out whether emphatic spread in the two styles is to be attributed to the phonology or to the phonetics. Keating's and Cohn's findings will be referred to in the discussion.

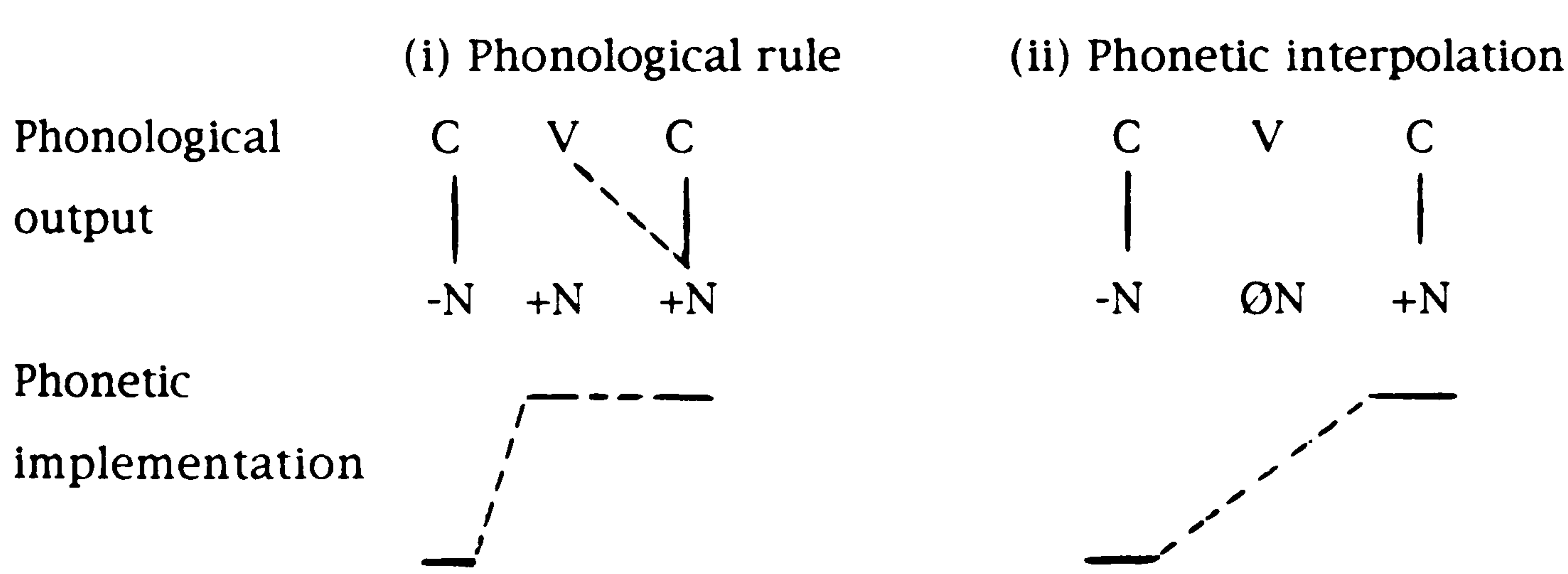


Fig. (67): Predicted outputs for VN pattern in English (Cohn 1993)

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of airflow and context should also be considered.

Phonological output:

(i) d i: n (ii) n i: d

-N +N +N -N

Phonetic implementation:

Target assignment

Interpolation

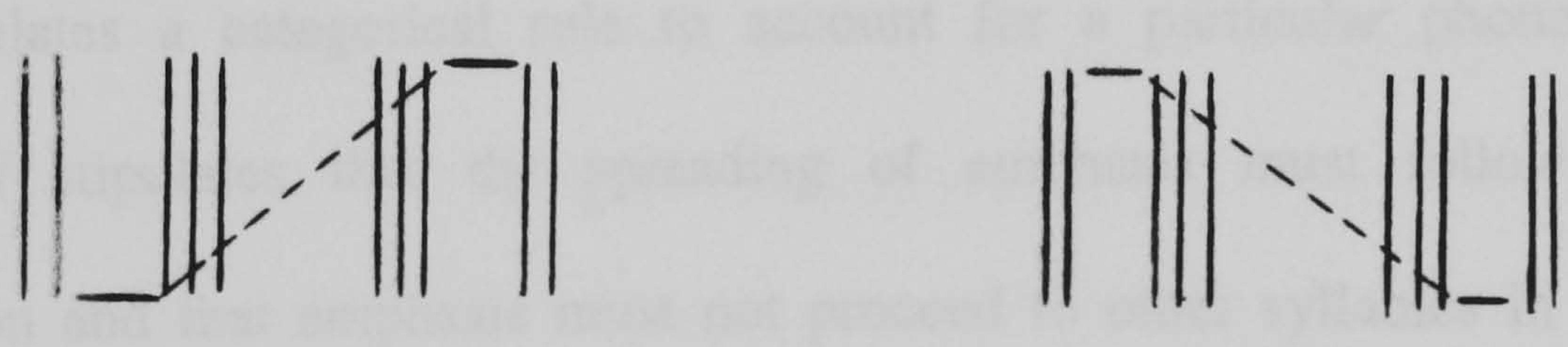

Fig. (68): Transitional amount of nasality through target-interpolation in English *dean* /di:n/ and *need* /ni:d/

5.2.2 Emphasis in CA/MSA: phonology or phonetics?

5.2.2.1 Underspecification in *tajwid*

It is quite possible to observe some similarities between *tajwid* and *SPE* theories of feature redundancy and phonological underspecification. In *tajwid*, vowels carry no phonological specification for [emph] but they rather exhibit emphasis or plainness from the immediately preceding consonant in CV strings. To put in *SPE* terms, vowels in recitation style are underspecified for [emph], which is basically a consonantal feature. Since each segment in *tajwid*, whether consonant or vowel, is required to preserve its full values (i.e. features) when it is articulated, it can be assumed that emphatic spread in CA is traditionally treated as a categorical rule. The reason is that although vowels are not marked for [emph] in the underlying level they must end up fully specified for such feature in the phonetic output. Accordingly, the *tajwid* approach to emphasis is quite similar in some respects to the way *SPE* handles anticipatory nasalization in English. More specifically, both approaches adopt fill-in rules to ensure that the phonetic realization contains no underspecified segments. Each approach thus formulates a categorical rule to account for a particular phonetic phenomenon. *Tajwid* stipulates that the spreading of emphasis must follow a perseverative direction and that emphasis must not proceed to other syllables in an utterance. We will test below the validity of the traditional assumptions that emphatic assimilation is categorical in the light of the acoustic measurements.

5.2.2.2 Emphasis as a unary/gradient feature

It was shown in Chapter Four that [emph] is likely to be a unary feature. In other words, traditional [plain] is not a real contrastive feature but it is rather a base-line value which is shared by all speakers and styles. Unlike emphasis, which clearly has a wide range of variability, plainness cannot be exaggerated because there is nothing to exaggerate. Emphasis, on the other hand, can be exaggerated and that is basically why it is usually more extreme in recitation than in ordinary reading style. The reciter does not exaggerate the contrast between emphasis and plainness by pulling the ends apart. One end (which is [plain]) is fixed and it is the other end which he moves. This is the explanation we have proposed for the fact that all the speakers we examined had the same PP vowel trajectories with all styles but differed considerably as regards the emphatic trajectories. Accordingly, it could be argued that emphasis is a unary feature. Just because tradition has a feature name for 'non-emphatic' that does not have to mean that we should expect to find polar oppositions of plus and minus values. If there is any expectation at all about a theory that supports the notion that features are unary rather than binary, as done by government phonologists for example, then our data is very consistent with it. This point may be addressed in future studies.

Because emphasis is a unary feature it apparently has a wide range of variability as stated above. Actually, this phenomenon was observed by Ali and Daniloff (1974) in their study of the perception of emphasis (Chapter Three). According to them, the ability to perceive emphasis is dependent on the degree or amount of emphasis. Exaggerating emphasis constantly led their listeners to perceive emphasis unmistakably. Conversely, by decreasing the amount of the emphatic stimuli the listeners gradually tended to identify the presence of a plain vowel. Yet they were sometimes unsure the vowel was emphatic or plain. It seems that Ali and Daniloff were not interested in the gradient nature of emphasis as much as in the question whether it is the consonant or the vowel which is responsible for the perception of emphasis. That is why they recommended further studies that could be needed to reveal in what way phonetic context can affect the perception of emphasis. We think that their findings are consistent with the assumption that emphasis is a gradient feature and a continuum that ranges from the least emphatic to the most emphatic sound. It was also seen previously that a number of investigators including Harrell (1957), Kahn (1975), Royal (1985) and Laradi (1983) report that female speakers generally tend to produce less emphatic sounds than male speakers. Bukshaisha (1985) further reports that the gradualness of emphasis is manifested acoustically with the gradual lowering of the second formant of the vowel occurring in the vicinity of emphatics. These assumptions give support to the notion that emphasis is a gradient feature.

Following the same line of argument that emphasis is a gradient feature, Card (1983) distinguishes between primary emphatics such as /ṣ/ and secondary (allophonic) emphatics such as [ṣ] which is originally the plain counterpart of the former. She reports that in the former case F2 of the adjacent vowel is consistently lower. Keating (1988 and 1990) argues that her preliminary data, like those reported by Ghazeli (1977) and Card (1983), give her the impression that emphasis is gradient, i.e. non-categorical. She points to one difference between Russian and Arabic stating that in the former [emph] occurs in a given segment with either '+' or '-' values, i.e. it does not show any pattern of variability unlike in Arabic where only one value appears to exist. That clearly implies that emphasis is unary and, according to her proposal, the variability of [emph] allows the occurrence of vowel interaction (i.e. coarticulation) in VCV strings. Although she did not examine her assumptions closely or attempt to develop a theoretical model that would account for her observations, she implicitly showed that emphatic spread in Arabic could be a phonetic phenomenon rather than a categorical rule of assimilation. We can further assume that the traditional notion of *marātib al-tafkhīm* 'degrees of emphasis' is consistent with the gradualness of emphasis. It was seen in Chapter Three that emphasis is traditionally classified into degrees according to the amount of emphasis which the different vowels exhibit in emphatic environments. Thus, [a:], for example, is more emphatic than [a] and [u:] is more emphatic than [i:]. Obviously, this is an impressionistic description which is subject to empirical assessment. But it is now very clear that the traditionalists also think of emphasis as a variable phonetic phenomenon that has a range of more or less emphatic targets. In other words, they also mean that emphasis is a gradient feature.

5.2.2.3 The asymmetry: evidence against surface underspecification

The EP measurements demonstrated that emphasis is gradient and that its gradualness is the result of differences in style, context, and expertise. This finding is quite consistent with the findings and proposals reported above by Keating (1988), Ghazeli (1977) and Card (1983). Let us now examine the EP context by adopting Cohn's target-and-interpolation model (1993) in order to decide whether the intervening vowel is marked or unmarked for [emph] on the surface. Cohn found that in English vowel nasalization is gradient rather than categorical, unlike in French or Sundanese. Her evidence for that is the negligible nasal airflow which was produced during the articulation of English vowels. The nasal airflow traces were gradual and the transitions into and out of the vowels were not abrupt or plateau-like. Accordingly, she rejects the assumption that anticipatory nasalization in English is phonological. By comparing her results to those reported in this study it is possible to assume that, like nasalization in English, emphasis in CA is not marked on the vowels. In other words, because the transition into and out of the vowel is gradient (as demonstrated by F2 measurements) the vowel could remain underspecified for emphasis in the phonetics. Following Keating's hypothesis of phonetic transparency (1988), the vowel in this case fails to receive a value for [+emph] in the phonology either lexically or by a later rule. It will consequently be transparent in the phonetics to any rule sensitive to emphasis but, at the same time, it will remain unmarked for this feature. Therefore, the vowel actually contributes nothing of its own to the EP trajectory. These points are consistent with our understanding of the difference between phonetic and phonological rules. By considering the EP trajectories, in particular, there seems to be no good reason for why one would not accept the assumption that emphasis in CA/MSA involves a case of phonetic underspecification. The gradually lower second formant in the EP/EE trajectories explicitly matches with the assumptions raised by Keating and Cohn. Fig. (69) expresses the similarity between our findings and those of Cohn (1993). In each case, the initial and final consonants receive phonetic targets which are connected through interpolation. The intervening vowel only receives a transitional amount of the feature of the preceding consonant through its duration. In other words, the phonetic interpolation occurs through an unspecified span rather than as a categorical rule.[30]

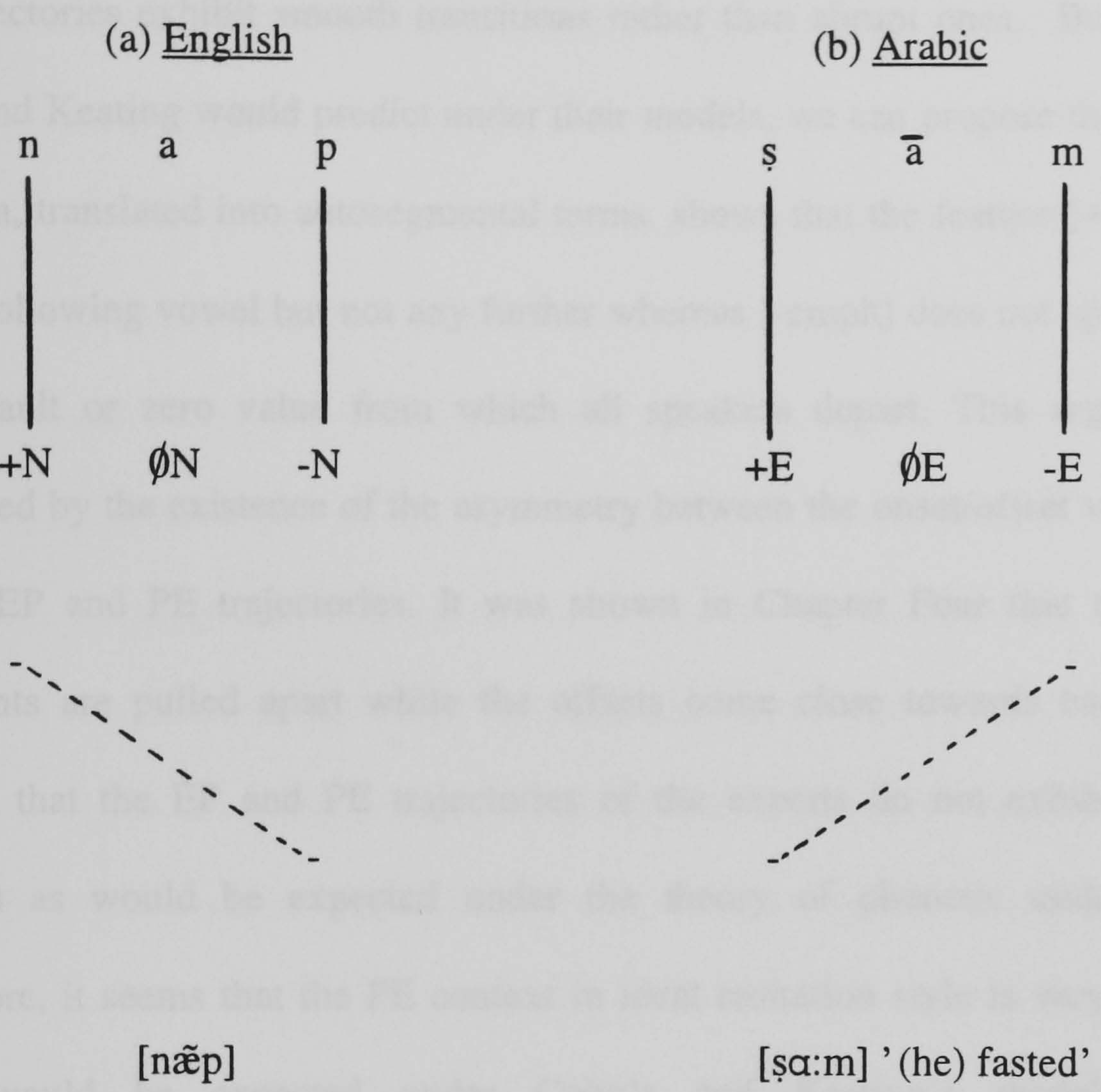

Fig. (69): Surface underspecification in English nasalization and Arabic emphasis

E: [emph]
N: [nasal]

Our findings regarding the gradualness of emphasis in EP vowel trajectories are consistent with Cohn's and Keating's proposals as stated above. That could definitely weaken the assumption that *tajwid* gives every single segment its full phonological

[30] The use of [emph] as a binary feature in autosegmental representation as done by Cohn (1993)

value in the phonetic output. That is, the phonological situation in CA clearly appears to be the kind of phenomenon that Cohn and Keating are talking about. We have got a specification on the consonants but we do not get one on the vowels. That is why the EP trajectories exhibit smooth transitions rather than abrupt ones. But against what Cohn and Keating would predict under their models, we can propose that the classical tradition, translated into autosegmental terms, shows that the feature [+emph] spreads to the following vowel but not any further whereas [-emph] does not spread since it is the default or zero value from which all speakers depart. This argument can be supported by the existence of the asymmetry between the onset/offset vowel positions in the EP and PE trajectories. It was shown in Chapter Four that the onsets and midpoints are pulled apart while the offsets come close towards each other. That implies that the EP and PE trajectories of the experts do not exhibit symmetrical patterns as would be expected under the theory of phonetic underspecification. Therefore, it seems that the PE context in ideal recitation style is very definitely not what would be expected under Cohn's and Keating's models. If surface underspecification is applicable to one vowel context (EP) but not the other (PE) that would apparently lead to contradictions in the theory itself. The vowels on either side of the consonant are supposed to be underspecified and the transitions into and out of the consonant should exhibit gradient and symmetrical patterns. In other words, one would expect to see symmetrical trajectories where the midpoints cross over. However, what we observed was asymmetrical trajectories. Therefore, Cohn's and Keating's approach cannot account for our data.

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contradicts our claim that emphasis is unary. This problem will be discussed later.

It might be possible in future studies of surface underspecification to shed more light on this problem and make useful predictions about emphatic coarticulation. For example, it might be possible to find out that emphatic spread could involve a case of surface underspecification but it requires the use of different models that account for an exceptional phenomenon like the asymmetry. In the meantime, we will assume that the asymmetry seen in the EP/PE vowel trajectories could simply be taken to imply that in CA [+emph] spreads categorically to the vowel in a perseverative direction whereas [-emph] does not spread at all because it is the default level of F2 which is shared by all speakes and styles. It would of course also be possible to explain the asymmetry by suggesting that the vowel is specified for plainness in the PE context whereas it remains underspecified for emphasis in the EP context. But that would clearly contradict the evidence from the difference among speakers and styles and that [plain] is actually a zero value while [emph] is the kind of feature which can be identified.

In summary, the asymmetry of the EP and PE trajcectories gives support to a categorical interpretation of emphatic assimilation in CA. There exist two pieces of evidence that the experts use a perseverative emphatic spread:

(i) both the onsets and midpoints of the PE/EP trajectories are clearly pulled apart for the experts. The trajectories do not cross at the midpoints but only towards the end of the vowels. That could imply that the vowel in the PE context does not really undergo a phonetic change until the very last moment.

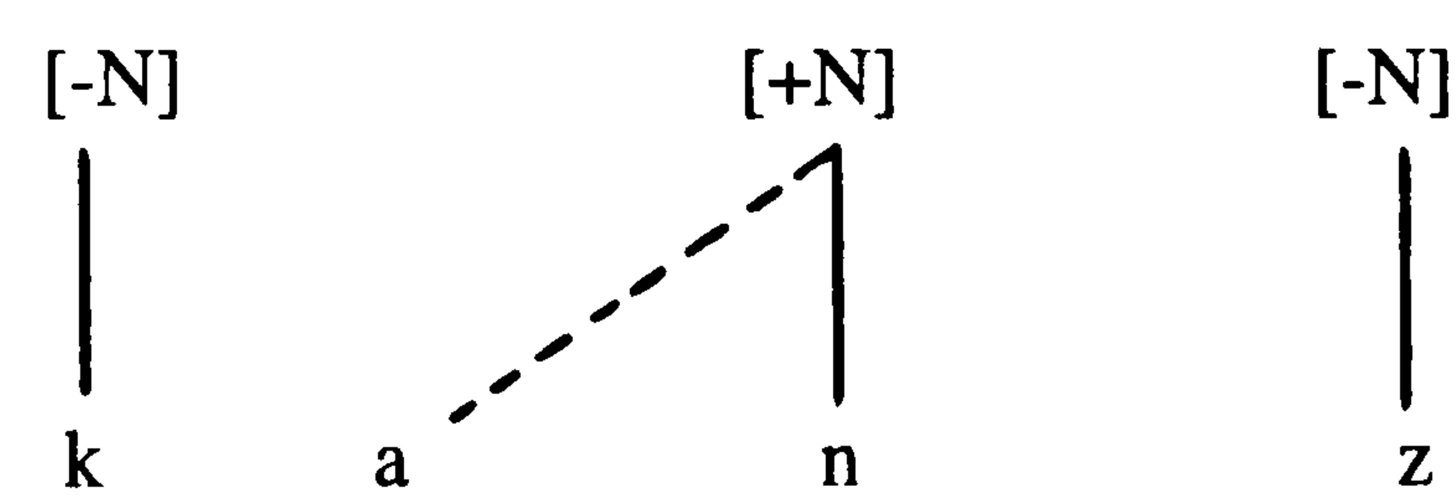
(ii) the experts consistenly exhibit the highest P in the PE context and the lowest E in the EP context especially if they are compared to the non-experts. In other words, while the vowel in the former context remains non-emphatic it exhibits the largest amount of emphasis in the latter context. These assumptions are consistent with our observation that the more educated style the reciter follows the greater the contrast he draws between the vowel values before and after the emphatic consonant.

The *tajwid* phonology stipulates that the spreading must be unidirectional and it also bounds its domain to the emphatic syllable whereas it is usually bidirectional and may extend over several syllables in other styles including MSA. The status of emphasis in the phonology, the difference between completely emphatic and completely plain trajectories and also between the experts and ordinary speakers may be used along with our findings about the asymmetrical patterns seen in the PE/EP trajectories to support the claim that emphatic spread is not redundant in the phonetics. In cases where exists no asymmetry as with some non-experts phonetic underspecification may be involved. Therefore, it is possible to argue that the experts are trying to realize the *tajwid* descriptions of emphasis in VCV strings. They try to make the first vowel plain and the second vowel emphatic. That would definitely be consistent with a phonological reading of recitation. However, if we postulate that emphasis spreads categorically either in a single direction as for the experts or in both directions as for the non-experts we will have to decide when the output changes from being directional spreading to being just unidirectional spreading. The problem is that the phonetic effect of emphasis on the vowel is realized as a continuum whether the speaker is an expert or not. So, what we would expect to see is mainly the lowering of the second formant of the vowel. The non-experts' normal speaking style is the least emphatic and the experts' recitation style is the most emphatic. It is, therefore, implausible to suggest that only the experts are producing an emphatic vowel. Somewhere along the line in learning how to recite properly and also when shifting from one style to another in a given situation the experts abruptly switch off bidirectional spreading and use only spreading to the following vowel. But since our data shows no clear evidence for that our claim, that a categorical distinction between two patterns of spreading is still difficult to justify.

5.3 Problems with the autosegmental approach to emphatic spread

The preliminary autosegmental representations shown in Fig. (60) (section 5.1) indicate that, for each syllable in every single utterance, the feature [+emph] either spreads or does not spread. The direction and domain of spreading is conditioned by the speaker's expertise. So, if the reciter is an expert, as in this case, [+emph] will spread perseveratively and its domain will be bounded to the emphatic syllable. Accordingly, *ṭaghā* 'he exceeded bounds' is entirely emphatic because the two vowels are preceded by emphatic consonants whereas in *biḍanīn* 'withhold grudgingly' only the second syllable is emphatic whereas the other syllables would remain plain. We can, therefore, predict that in utterances like *faṣl* 'separation' and *barr* 'land' [+emph] will be restricted to [ṣ] and [ṛṛ] and will not spread in any direction. On the other hand, the non-expert spreads emphasis in both directions.

The main problem with the above approach to emphatic spreading is that it does not explicitly account for the blocking of emphasis. Following the original autosegmental framework originally proposed by Goldsmith (1976) and developed by Clements (1976) a feature spreading can carry on until it is blocked by a contrasting feature with a clear negative value on the same tier. For example, English segments are either marked or unmarked for [nasal]. An autosegmental representation of *cans* /kænz/ in shown in Fig. (70). Note that [+nasal] spreads from /n/ to the preceding vowel but it is blocked by the other two consonants because they are marked for [-nasal]. The association lines cannot thus cross. Although the assumption that the vowel exhibits [+nasal] does not appeal to Cohn (1993), she managed to develop her target-and-interpolation model within the autosegmental framework. The reason is that [nasal] is a binary feature which is explicitly marked for '+' and '-' values.[31] She could accordingly argue that the vowel is not marked for nasality but it merely exhibits a small amount of nasal airflow through phonetic interpolation.



[kæ̃nz]

Fig. (70): Anticipatory nasal spread in English *cans*

There exists strong empirical evidence that [emph] is a unary feature. This implies that the association of *plus* and *minus* values with this feature is not necessary in formal representations. There is no clear negative value of the sort [-emph] as

[31] See, for example, Ladefoged (1997) and Spencer (1996) for their argument that English [nasal] is a binary feature.

such.[32] The question is that how emphasis can be blocked while there exists no underlying [-emph] to block it? Unfortunately, we have no clear answer to that but only some suggestions.

In the case of CA when recited by the experts, it may be proposed that blocking is not needed regardless of whether [emph] is binary or unary. That is, there would be only spreading. It might also be possible to introduce a language-specific rule and allow it to operate under certain conditions before the phonetic derivation is completed. Such a rule can ensure that emphasis will only spread within the syllable boundaries and in a single direction. Accordingly, blocking can be preserved indirectly, but the conventional featural blocking framework will have to be developed so as to explicitly account for the unarism of emphasis in CA. On the other hand, the blocking of emphasis in MSA and colloquials is more problematic because emphasis usually spreads over several syllables in both directions. Regional dialects vary in this respect, as stated earlier, but they apparently employ a larger scope of spreading than CA. We would thus expect the need for blocking. The problem, however, is that the autosegmental models that have been proposed so far (e.g. Card 1983, Hoberman 1989, Younes 1993 and Davis 1993) give a different account of blocking as we saw before. Featural blocking in these models is not abstract, but is a purely phonetic phenomenon. The current view is that all segments can be marked for emphasis except a small number of segments that resist this feature articulatorily (Ghazeli 1977) and maybe acoustically (Card 1983) so that the spreading is either weakened or

[32] The non-existence of a clear negative value for [emph] makes it difficult for people like Keating and Cohn to apply their assumptions to our data. I suppose that this is a further evidence against surface underspecification in addition to the asymmetry. There exist no contrasting values which will accordingly connected through phonetic interpolation.

entirely blocked. Emphasis blockers (also known segments which are opaque to emphatic spreading) could vary from one dialect to another depending on differences in the grammar (Davis 1993). But it is generally assumed that the main emphasis blockers are palatal vowels (/i(:)/), /ʃ/, /dʒ/ and /j/.

It might be possible that this phonetic approach (which may not be accurate) to the notion of blocking has been influenced by some previous physiological studies of emphasis such as Ali and Daniloff (1972) and Ghazeli (1977). For example, Ghazeli argues that since /i/ and /i:/ involve articulatory movements which are contradictory to emphatic coarticulation (he means the forward movement of the tongue for the two vowels as opposed to the depression and backing of the tongue dorsum) the two sounds weaken the spread of emphasis to neighbouring segments. But it does not appear that Ghazeli could examine this hypothesis closely not only from a theoretical perspective but also from a purely phonetic point of view. For example, it might be true that the inherent articulatory properties of /i:/ make it less amenable to emphatic coarticulation than /a:/. But in utterances like *basīṭah* 'it is simple' and *faṣīlah* 'category/group' in Hejazi Arabic /i:/ does not weaken or block the effect of the emphatic gesture and both utterances are, indeed, impressionistically realized as entirely emphatic. Although Davis (1993) explicitly attributes differences in blocking to the phonologies of Arabic dialects neither Davis nor other phonologists could come up with a consistent picture for the abstract blocking of emphasis. It is not yet clear how it is possible to consider blocking a mechanical process which is imposed by the vocal organs' muscular activities and, at the same time, claim that it is language-specific as done here by Davis. Also, it was seen before that from the acoustic point of view, the vowels that occur in the vicinity of emphatics (especially /i(:)/ and /a(:)/) are affected by getting their F2 lowered regardless of changes in the patterns of their transitions. That is, the effect is phonetically realized but it could be small as reported, for example, by El-Dalee (1984) and Al-Ani (1970). Therefore, the claim that /i(:)/ is never affected by neighbouring emphatics and that it resists emphatic spread will remain questionable. In general, we think that it is more appropriate to treat blocking as an abstract rather than as a purely physiological behaviour. Contemporary Arabic dialects offer a wide range of unpredictable variation in the spreading and blocking of emphasis. The notion of physiological blocking apparently fails to account for several exceptional cases in those dialects.

We think that one of the main problems with the autosegmental analysis of emphasis in CA is the empirical evidence that there exists no real plain feature value that would spread categorically from a plain segment and also block the spreading of emphasis to other segments. That could cast some doubt on the appropriateness of the autosegmental approach and its suitability for a formal analysis of emphatic assimilation in Arabic. Indeed, if we speculate on this problem more deeply we will observe that since emphasis is unary it will only occasionally spread. In other words, we will not have full specification for emphasis on all segments in numerous utterances. Therefore, what we will get in some sense is an argument for an even more dramatic surface underspecification view than the one which Cohn and Keating propose despite the problems that arose when we applied their theories to our data. In any case, we have to acknowlege the kind of contradiction which the current autosegmental approaches seem to invoke in relation to emphasis.

Another problem with the autosegmental approach to emphasis in CA is that it does not apparently account for the phonetic differences between various categories of speakers and styles. These differences are manifested acoustically by an even more lowered second formant for the experts/CA. Since the difference between experts and ordinary speakers is crucial to *tajwid* as an oral skill which is language-specific, it is appropriate to be able to represent it in formal representations of emphatic spreading. The current models only show that emphasis either spreads or does not spread. They do not, however, show that a given vowel could further be more emphatic or less emphatic depending on to speaker, style and context. Compare the four representations in Fig. (71). Note that we cannot rely on them for indicating the phonetic difference.

<u>Expert/CA</u>

(i)

[emph]

ṭ a b a q

[ṭɑbaq]

<u>Non-expert/MSA</u>

(ii)

[emph]

ṭ a b a q

[ṭɑbaq]

<u>Expert/CA</u>

(iii)

[emph] [emph]

ṭ a gh ā

[ṭaʁɑ:]

<u>Non-expert/MSA</u>

(iv)

[emph] [emph]

ṭ a gh ā

[ṭaʁɑ:]

Fig. (71): Problems with the autosegmental approach to emphatic spreading in CA

Actually, Card (1983) encountered a similar problem with her autosegmental analysis of Palestinian Arabic. She states that there is no clear method to show the phonetic difference between an underlying/phonemic segment such as /t/ and an allophonic [t] which is emphatic in certain phonetic/context, but not underlyingly. Her measurements indicated that the F2 formant value of the vowel adjacent to the emphatic consonant is more lowered. For example, she found that the underlyingly emphatic [ṭ] in [ṭaṃṃ] (originally /ṭamm/ 'to overflow') and the derived emphatic [ṭ] in [ḍaṣaṭ] (originally /ḍaṣat/; meaning unknown) exhibited the mean values of 1473 Hz and 1237 Hz, respectively, for four speakers. Card did not explore whether the difference between the two values (237 Hz) was statistically significant or not but her argument is worth consideration. She clearly touches upon a serious autosegmental gap which has not yet been bridged. Her models are indicated in Fig. (72) below. It is not possible to decide which [ṭ] is phonemic and which [ṭ] is phonetic by referring to the phonetic output only. In fact, the phonetic output does not itself show that different phonetic realizations of different phonemes are involved here. She describes this problem briefly but does not speculate on possible solutions, and she decides that "despite these difficulties, autosegmental phonology provides the best analysis of emphasis in Arabic available" (p. 152).

(a) Spreading on the phonological level

(b) Phonetic output

Fig. (72): The problem of distinguishing between emphatics and quasi-emphatics in autosegmental representations (Card 1983)

Keating (1990) makes reference to Card's findings and argues that since underlying emphatics are more emphatic than derived segments a phonetic analysis of this phenomenon should be warranted. She explicitly states that "categorical phonological rules cannot describe such effects" (p.453). In other words, she means that a surface underspecification could be involved here because emphasis is realized phonetically as a gradient and quantitative feature. We have already discussed this problem in the preceding sections so there is no point at repeating it here. But we think that a fully adequate autosegmental analysis of emphasis in *tajwid* should be able to account for quantitative data. The models that have been so far proposed in the literature (including the one of Card 1983) did not handle this problem. It is not yet clear how language-specific phonetic rules of emphasis can be formulated and derived in a formal representation. It is also not clear whether these rules are categorical or gradient because it is not clear whether the spreading of emphasis is a phonological or a phonetic phenomenon. But we definitely need to develop at least two types of rules.

The first type would determine the direction of the spreading and the segments that can block it. The second type would specify the extent of F2 lowering (or the size of the emphatic gesture) and lip position (e.g. close rounded, open rounded, etc.). We expect that this approach which apparently integrates the phonology and the phonetics in certain respects would not only apply to CA or MSA but to other styles of Arabic as well. In the case of CA, these rules would be sensitive to expertise and context.

5.4 Constraints on emphatic coarticulation in CA

In Chapter Four we discussed the asymmetry between the onsets and offsets in the PE and EP vowel trajectories in recitation style as compared to the relatively smooth interpolations in ordinary Modern Standard where the midpoints cross especially with the non-experts. This is relevant to current theories of speech motor control such as the notion of coarticulation resistance first adopted by Bladon and Al-Bamerni (1976) which will be discussed in this section.

It is quite possible to divide constraints on coarticulation into physiological, related to inherent characteristics of the speech mechanism, and linguistic, related to the phonological, syntactic and semantic rules of the language (Hardcastle and Roach 1979). Physiological constraints are universal since all speakers of the world's languages have the same kind of vocal tracts. Certain sounds have certain requirements of muscular activity. For instance, when a speaker wants to produce alveolar /ṭ/ he has to raise his tongue tip and resist to any kind of pulling it down simultaneously to produce another gesture that requires the tongue tip to be lowered. Consequently, the following gesture may not be initiated very soon because of the requirement that the articulator must remain raised for a given duration. According to Farnetani (1997), fricatives must constrain the tongue back position to ensure the appropriate front constriction and the intraoral pressure required for noise production. She suggests that the production of stops and laterals imposes fewer constraints and allows for a wider range of coarticulatory variations. By considering the *tajwid* description that vowels follow preceding consonants in respect of emphasis and plainness we can similarly argue that vowels in CA are sensitive to coarticulation from neighbouring consonants. That could be attributed to the inherent articulatory properties of vowels and possibly the properties of the coarticulating consonants.

Bladon and Al-Bamerni (1976) conducted an acoustic study of vowel-to-consonant coarticulation in British RP [ɫ̩] (syllabic), [ḷ] and [l]. They analyzed the speech of four adult male native speakers and examined more than 200 items containing /l/ in a variety of contexts. Their main finding is that coarticulatory lateral variations increase continuously from syllabic to clear /l/. For example, by comparing *terrible, feel* and *leaf* they found that syllabic [ɫ̩] is highly resistant to lateral-quality coarticulation and [ḷ] is less resistant while [l] coarticulates more freely. Bladon and Al-Bamerni argue that there is no obvious phonetic reason why /l/ should be dark in a final position in RP while it is clear in other varieties/languages such as Irish English and standard German. Accordingly, these differences between the three lateral allophones appear to be context-sensitive and language-specific. They cannot simply be ascribed to phonetic feature spreading from the context. This finding agrees with Ladefoged (1973) who states that canonical forms are required not simply for each phoneme, but rather for each extrinsic allophone. It is also consistent with

Kozhevnikov and Chistovich's (1965) theory of the articulatory syllable (see section 5.2.1 above). Coarticulation in this particular sense is constrained within the syllable but, at the same time, the direction of coarticulatory effects (anticipatory or perseverative) is not important. That apparently rules out the view adopted by Daniloff and Hammarberg (1973) who consider perseverative coarticulation the result of mechano-inertial properties of the vocal tract musculature and limits deliberate neurological control to anticipatory coarticulation. In other words, coarticulation appears to be pre-planned and cannot always be explained in purely phonetic terms regardless of its direction. This supports the view held by Hardcastle and Roach (1979), among others, that some coarticulations are language-specific. It is further in accordance with Keating' argument (1990) that graded variations (such as with /l/ in RP) are not to be ascribed to phonetic universals of different languages.

In order to account for the control of coarticulation Bladon and Al-Bamerni propose an index of coarticulatory resistance. The idea is simply that certain segments are somewhat insensitive to coarticulation as dark /l/ in *feel* whereas others are highly sensitive or susceptible to coarticulation such as clear /l/ in *leaf*. Therefore, they postulate the notion of coarticulation resistance (CR) as the central principle of articulatory control. The hypothesis is that the speech production mechanism has continuous access to CR information which is initially stored linguistically as a scalar feature specification like any other separate segmental feature. Accordingly, a given segment would be assigned its usual phonetic features and, at the same time, it could be associated with a numerical value for CR. For example, Bladon (1979) states that English /h/ is highly sensitive to coarticulation whereas /θ/ is much more resistant.

Therefore, he specifies them for [1 CR] and [5 CR], respectively.[33] He further adopts an approach which is analogous to feature blocking by stipulating that coarticulation may proceed freely in either direction until impeded by a specification of [CR] on some segment. Keating (1990) argues that in her model high coarticulatory resistance corresponds directly to a narrow window and a lack of such resistance corresponds directly to a large window.

The general problem of emphatic coarticulation is consistent with the assumptions raised by Bladon and Al-Bamerni (1976) and Bladon (1979). Previous studies of emphasis in Arabic (e.g. Ghazeli 1977, Laradi 1983, Al-Ani 1970, Al-Ani and El-Dalee 1984, Herzallah 1990 and Parkhurst 1990) showed that /a(:)/ is highly sensitive to emphatic coarticulation while the other vowels are less sensitive. A similar point is made by *tajwid* scholars, both early and contemporary (e.g. Al-Dāni; d. 1052, Ibn Al-Jazari; d. 1429, Al-Marṣafi 1982 and Miṣri 1991). By considering the notion of coarticulation resistance, /a/ may be given the value of [1 CR]. In other words, it is highly sensitive to coarticulatory effects from neighbouring emphatics, much as clear /l/ is sensitive to coarticulatory effects from /i:/ in RP.

However, our findings show a directionality in CR that is not allowed for by Bladon and Al-Bamerni because in CA the vowel must follow the feature of the preceding consonant and not that of the following consonant. The asymmetry between the relative vowel positions in the EP/PE trajectories of the experts' recitations, in particular, contradicts the widely accepted view that any low vowel in the vicinity of an emphatic consonant must inevitably become emphatic (Parkhurst 1990). It also

[33] It is not clear why Bladon (1979) divides the featural scale into 5 degrees. However, his view of coarticulatory resistance is clear.

partly contradicts Bukshaisha's assumption (1985) that the contiguous vowels in VCV string exhibit more emphasis than other segments in the same utterance since they are closer to the source of emphasis (Chapter Three). Our expectation is that the asymmetry could be the acoustic outcome of the vowel's resistance to the coarticulatory effect of the emphatic consonant in the PE context. If the vowel does not resist emphasis there would be no asymmetry before and after the emphatic consonant. It is also important to note that the asymmetry should not be taken as the only evidence for coarticulation resistance. There also exists the gradually higher F2 in the PE context which correlates with expertise and style, so that the more fluent the reciter and the better style he follows the higher F2 value. In other words, good reciters attempt to retain the vowel in PE context as plain as possible and that naturally gets them to reach high F2 scores. By contrast, they want to achieve the most emphatic vowel allophones wherever emphasis is supposed to spread perseveratively to the following vowel. That is consistent with the finding that the experts exhibited the lowest F2 values, especially in the EE context. The main argument to emphasize here is that there exists strong empirical evidence that some of our speakers exhibit coarticulation resistance in one from or another.

The question is then why emphasis is resisted in certain contexts but not in some others. In other words, why is it that C-to-V coarticulation is not recommended in PE context? The phonetics alone cannot account for this aspect of the *tajwid* performance. From the articulatory standpoint, there is no clear explanation for why that should be the case. The experts could have made the vowel emphatic regardless of the position of the emphatic consonant as was done by the non-experts. However, coarticulation in standard recitation style is probably not mechanical, and the same principle would apply to coarticulation resistance as well. That may give rise to the assumption that the asymmetry could be the result of applying the *tajwid* rule which stipulates that emphatic coarticulation must be maximal within the emphatic syllable 'CV(:)' but minimal across its boundaries.

It should be noted that, according to Kozhevnikov and Chistovich (1965), anticipatory coarticulation tends to be maximal within the syllable and minimal across its boundaries. They assume that a syllable is a grammatical articulatory unit which is composed of any number of consonants plus a vowel. Their approach probably gave rise to the theory of articulatory syllable. Actually, the theory itself fails to account for a number of coarticulatory phenomena (e.g. anticipatory nasalization in English as stated in Bladon 1979). Yet, Bladon and Al-Bamerni argue that its predictions are consistent with their findings as regards coarticulatory lateral-quality in RP. But they put more constraints on the direction of coarticulation by stating that perseverative coarticulation "also appears to be constrained by the same notion of articulatory syllable" (p. 148). That clearly implies that the direction of coarticulatory effect is based on one uniform control principle. One may speculate that the same principles could apply to emphasis in CA.

Recall that *ḥarf* in *tajwid* means 'segment' whether consonant or vowel. It was stated in Chapter One that *tajwid* gives every segment its full phonological value. Al-Nassir (1993), in his review of Sibawayh (d. 809), concludes that *ḥarf* could further mean 'syllable'. The early scholars had a special interest in syllables as dynamic articulatory units that differ from individual static consonants and vowels. The minimum unit, according to Sibawayh, is thus CV(:). Al-Nassir's interpretation is actually consistent with Denny's comment (1989) that an ideal *tajwid* target can be achieved by reciting the *Qur'an* segment by segment, i.e. syllable by syllable. This does not, of course, mean that the articulations will not overlap, but it rather means that the overlapping is controlled and constrained to some extent. Al-Dāni (d. 1052) describes this kind of speech control in recitation by adopting the notion of *tafkīk al-ḥurūf* 'disjoining of segments/syllables'. Articulatorily, it is possible to produce a sequence of syllables without overlap as in *ṣabara* 'he patiently preserved'. This utterance can be divided into three mono-syllabic units: *ṣa # ba # ra.* Al-Dāni claims that fluent reciters usually follow articulatory strategies that allow them to minimize the gestural overlap to the minimal possible limit especially in sequences of potentially conflicting gestures such as in *ṣabara* above. We assume that the above traditional claims, namely the ones that view the syllable as a semi-independent articulatory unit are to some extent consistent with the notion of articulatory syllable. But it should also be noted that the articulatory syllable in Kozhevnikov and Chistovich consists of any number of consonants followed by a vowel. Their notion is based on facts of Russian where palatalization and velarization (or absence of palatalization) spread from a vowel back through all the preceding consonants. Accordingly, the consonants would be coarticulated for a given gesture. Typically, that should be applicable to a string like ÇCV in Classical Arabic. However, the strings [-ʁtə-] and [-ṭṭə] in *baghtah* [bəʁtəh] 'suddenly' and *basaṭṭa* [bəsəṭṭə] '(you) spread', for example, are not wholly emphatic as it would be predicted under the theory of articulatory syllable. In *tajwid* the emphatic gesture must be constrained to the emphatic consonants and their following vowels. That clearly implies that plain consonants (/t/ in this above example) must remain plain even if they immediately follow an emphatic consonant. We think, however, that it is possible to adapt the notion of articulatory syllable for Arabic so as to have it include a single consonant and its following vowel. Thus, although the details of Kozhevnikov and Chistovich's proposal do not apply to CA, their general notion of the articulatory syllable could well apply to emphatic syllables in recitation style.

The points raised so far agree with Wood's (1995) assumption that coarticulation is pre-planned and that the bio-mechanical requirements of the vocal tract cannot account for language-specific preferences for certain patterns of coarticulation resistance. The vowel /a/ in CA is highly resistant to emphatic coarticulation in the PE context because *tajwid* stipulates that it must remain plain. It may be hypothesized, for example, that the front target position needs to be attained by the front of the tongue during the articulation of this vowel in order to meet the recommended phonetic target. It is also possible that coarticulatory resistance at the acoustic level follows not only from resistance during the articulation of the vowel but also in labial or mandibular (lower jaw) activity, i.e. before the vowel is actually produced. [34]

The notion of the articulatory syllable could be adapted to Classical Arabic with some modifications. An emphatic consonant in CA may be followed by a plain consonant rather than an emphatic consonant/vowel. In that case, *tajwid* would stipulate that each consonant in the string CC is to be given its full phonological value.

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[34] This is basically the assumption adopted by Recasens *et al* (1994) in their treatment of coarticulatory resistance for /l/ in Catalan and German.

In other words, a plain consonant which is immediately following an emphatic consonant is required to remain plain whereas a vowel that is following an emphatic consonant must be coloured with emphasis. Therefore, consonants should also be associated with a CR value in *tajwid* tradition and not only vowels.

5.5 Hyperarticulation and emphasis in CA

In this section we will deal briefly with the hyper-and-hypoarticualation hypothesis (H & H) of careful speech (Lindblom 1990) and see whether it is possible to interpret emphatic spread in CA according to its predictions. 'Hyper' refers to clear speech forms and 'hypo' to casual speech forms. Lindblom (1990) considers that speech production is a feedback system in which the input is the goal and the actual production is the output. The extent to which the output matches the input goal depends of the amplification of the feedback loop, which is analogous to effort. The input goal is the most distinctive, hyper-articulated speech, since this is the signal that the output approximates to as the gain is maximized. Reduction processes do not actually alter the goals but, rather, result from expending less effort and thus falling short of the goal (Johnson *et al* 1993). They are the result of hypoarticulation. Browman and Goldstein's (1986) analysis of casual speech within the framework of articulatory phonology is probably consistent with the hypothesis that there are both reduction and hyperarticulation processes. Casual speech variants of canonical lexical gestural representations are produced by increasing temporal overlap between gestures and reducing gestural magnitude spatially. It seems that hyperarticulation in their model can be expressed as decreasing overlap and increasing gestural magnitude. One implication of assuming that phonetic targets are hyper-articulated is that the search for the phonetic correlates of distinctive features will focus on hyper-articulated speech, a speech that has no reduced phonetic output. "If phonetic targets are hyper-articulated, the phonology-phonetics interface is not a mapping between phonological representations and normal speech but rather between phonological representations and very carefully articulated speech. Thus, the search for acoustic articulatory correlates of phonological units, in order to be successful, should focus on carefully produced speech" (Johnson *et al* 1993: 526). This is basically the assumption raised by Jakobson and Halle (1956: 16-7).

It could be assumed that *tajwid*, including the treatment of emphatic articulation, involves a case of hyperarticulation where the phonetic output is highly constrained and the phonemes are seen as having canonical variants. Indeed, that could apply to a variety of processes in *tajwid* and not merely to emphasis. Thus, a well-trained reciter is going to be careful to give long vowels their full length, to articulate clearly the glottal stop, to keep single segments single and doubled segments doubled, and to allow each nasal sound its proper nasality and duration. He would guard against any unrecommended form of shortening or vowel deletion and consume every possible effort to achieve the phonetic targets which he learnt to hyperarticulate. He would be able to reorganize his articulatory gestures and acoustic patterns and adjust his articulatory movements so as to ensure that he is attaining his ideal targets properly. Typically, gestural overlapping in CA will be so controlled that there would exist no undershoot effects. In other words, no canonical targets will be missed out. Acoustically, a hyperarticulated /i/ would thus have even more separated first and second formants and a hyperarticulated /u/ would have even the two formants closer together than in causal speech. In completely emphatic environments an over-coarticulated /a/ would get its F1 and F2 compressed together. If the vowel is required to remain plain, as in the PE context, the asymmetry could be very clear. Younes (1982) argues that plain segments that occur in emphatic environments could remain plain in careful speech. All these phenomena point to the possibility that emphasis in *tajwid* may well involve a case of hyperarticulation.

It should be pointed out, however, that this study has also reached the conclusion that *tajwid* is an oral skill that has to be learnt and practiced. Our speakers were all well educated. They were equally given enough time to recite the same material as carefully and slowly as they wished. Nevertheless, we saw that certain phonetic targets were more successfully met by some speakers than by some others. The finding that the acoustic targets exhibited by the trained reciters were attained only by them could imply that although *tajwid* can be regarded as a form of hyperarticulation certain recitation rules can hardly be put under the heading of careful speech. Some of the rules discussed in this thesis, including emphatic assimilation, suggest that there are phonological as well as phonetic differences between experts' CA recitation and other styles. More specifically, hyperarticulation alone may not account for emphatic coarticulation and its resistance in CA.

Nelson (1982) makes a comparison between reciters of the *Qur'an* and musicians. Her assumptions are consistent with our claims. She proposes that the reciter's skill is seen as greater than the singer's because he must perform within the stricter limitations imposed by the text. The reciter is bound to a comprehensive set of rules governing the oral rendition of the *Qur'an*. Thus, whereas the singer is relatively free to draw breath regardless of the sequence of the text, the reciter is required to observe complex rules as to where he may interrupt the sequence of the text, and whether he may have to continue in sequence of return to a previous point in the text. To quote her, "In other words, the challenge to the artistic talent of the reciter is considered greater because of the greater limitations placed on his choices as a performer" (p.42). According to Al-Fārūqi (1987) and Nelson (1982), in local and international competitions of recitation the performance of contestants is usually judged for several criteria that normally include:

(i) rules of *tajwid.*

(ii) *faṣāḥah* 'eloquence'.

(iii) the vocal quality of the reciter (voice should not be faint, harsh, etc.)

(vi) musicality (how sweet the reciter's melody).

(v) memorization of the text (how perfect the memorization).

We will shed some light on the relationship between hyperaticulation and criteria (i) and (ii) above for their relevance to the topic of this section. In the *tajwid* tradition (although the word itself is not commonly used in *tajwid* manuals) *faṣāhah* refers to the speaker's ability to avoid casual speech habits such as word repetitions, skipping of sounds, tongue slips, stuttering and the like. We think that *faṣāḥah* is closer to the notion of careful speech than the ability to practice recitation rules. So, the kind of phenomenon which Lindblom is talking about appears to fall under the heading of *faṣāḥah* whereas the essence of *tajwid* is phonological in spite of its obvious phonetic content.

It is also worth noting that within the *tajwid* tradition a distinction is drawn between the ability to manipulate recitation rules and the idea that reciters should not exaggerate sound productions. Good recitation is supposed to sound natural and not exaggerated. In other words, the notion of careful speech is not consistent with the traditional principle that an ideal recitation should sound natural, not affected or exaggerated. A recitation that follows *tajwid* is usually preferable, but the overarticulation of utterances should itself be controlled otherwise the communicative function of recitation would fail. To conclude, it is quite possible to assume that emphasis, particularly the increasing of the size of the emphatic gesture in certain contexts, may involve a form of hyperarticulation. However, this assumption does not rule out the possibility that *tajwid* goes far beyond what people usually do when they speak carefully because it does not only put emphasis on the application of rules but it also assures that recitation must sound natural.

5.6 Summary

The main purpose of this chapter was to investigate and assess the traditional assumption that the vowel /a/ is fully specified for emphasis in emphatic environments and that it is fully specified for plainness in plain environments. The investigation was based on both the empirical findings reported in the preceding chapter and the current version of the phonology-phonetics interface as presented in a number of studies (e.g. Pierrehumbert and Beckman 1988, Keating 1998 and 1990, and Cohn 1990 and 1993, among others). The empirical findings showed that some data are consistent with a phonetic reading of *tajwid.* The acoustic measurements of the vowel in EP context give support to the hypothesis that feature redundancy can persist into the phonetics and that certain segments maybe left underspecified for certain features on the surface (phonetic) representation. We could make the same judgement about the vowel in EP context. So, it was assumed that since the trajectories exhibited gradual and variable patterns for all the speakers and styles examined, the vowel is not categorically emphatic. In other words, emphasis does not spread to the vowel as it is traditionally assumed.

However, the theory of surface underspecification must account for both directions of coarticulation, perseverative and anticipatory, in order to be predictive and reliable. That is basically why Cohn had to examine vowel nasalization in both CVN and NVC strings before she could reach to the conclusion that anticipatory nasalization in English is not categorical. Her data were consistent with the phonetic approach she adopted because the nasal airflow patterns were symmetrical whether the vowel was preceded or followed by a nasal consonant. In each case, a smooth transition was seen. Accordingly, she could make a powerful argument in favour of the assumption that some quantitative data in speech are to be attributed to the grammar. But her approach was not consistent with our data simply because, particularly for the experts, the onset/offset positions in the EP/PE vowel trajectories were asymmetrical. All the experts exhibited asymmetrical vowel trajectories. If the vowel were underspecified for emphasis the trajectories would rather have shown smooth transitions across the vowel space or two similar shapes and their midpoints would have crossed, like with the poor non-experts. Also, it was implausible to assume that plainness spreads. The existence of the asymmetry did not imply that a feature spreads from the plain consonant to the vowel simply because plainness is the zero/default value which is shared by all speakers and styles. In other words, it was not appropriate to claim that a feature spreading can be realized in the PE context and that, on the contrary, an underspecified vowel can be realized in the EP context. The existence of the asymmetry implies that the surface underspecification approach, in its current version and theoretical framework, fails to account for the effect of emphasis on /a/, at least in experts' CA.

Bladon and Al-Bamerni's (1976) notion of coarticulation resistance is also not easy to reconcile with the asymmetry of the experts' EP/PE vowel trajectories. The fact that /a(:)/ is more sensitive to emphatic coarticulation than /i(:)/ and /u(:)/ is completely consistent with the notion of CR. However, the fact that CA phonology explicitly stipulates the directionality of the spreading of emphasis from the consonant to the following vowel is less easily handled by the notion of CR. We indicated that the vowel shows coarticulatory resistance to the upcoming emphatic gesture in good recitation style. By contrast, if the vowel is preceded by an emphatic consonant it becomes sensitive to emphatic coarticulation and, consequently, it shows a wide range of variability under the influence of emphasis. Therefore, it might be more appropriate to describe /a(:)/ not as a vowel that has a specific CR value but rather as one that exhibits the feature of the immediately preceding consonant. In other words, the vowel in CV(:) strings functions phonologically with the consonant as to make a larger articulatory unit. That will give support to the notion of articulatory syllable (Kozhevnikov and Chistovich 1965) which we saw is adopted by Bladon and Al-Bamerni and may well apply to our data with some modifications.

We further addressed the question whether emphasis (as well as other rules) can be regarded as a form of hyperarticulation or careful speech. It was proposed that some of the *tajwid* aspects may involve a case of hyperarticulation including, perhaps, the classical notion of *faṣāḥah* 'eloquence' which refers to care in pronunciation. But we also stated that the application of recitation rules does not very much involve careful speech and that an extra hyperarticulated recitation which is remarkable for exaggerating sound productions is not recommended in the *tajwid* discipline. A good recitation should sound natural.

The overall picture of this chapter showed that the predictive capacity of each of theories/models discussed so far was partly successful and partly unsuccessful. Cohn's target-and-interpolation model (1993), which is based on the assumption that phonetic rules are intrinsically gradient, failed to predict the existence of the asymmetry of the PE and EP trajectories. That clearly gives support to a phonological reading of a unidirectional emphatic spreading of in CA and therefore further contradicts the Cohn-Keating argument. We do not, of course, mean that surface underspecification does not exist. The main argument is that the current version of this theory cannot account for all our data, at least the recitation style. The *tajwid* view that segments should be given their full phonological values on the phonetic output thus appears to be more consistent with the view held in *SPE* that phonologically underspecified segments must end up fully specified on the surface.

To conclude our discussion, there exists some evidence that emphasis spreads categorically to the vowel in CV strings and that it is resisted in the PE vowel context. It became clear that emphasis is a variable phonetic phenomenon and that it is sensitive to the expertise of the speaker and the style he follows. The variability of emphasis, however, cannot be taken to imply that the vowel in the EP context could remain underspecified for emphasis on the surface. One of the implications of the variability and wide range of emphasis is that we have been analyzing the acoustic properties of a unary feature. However, it is not yet clear how to account for the blocking of emphasis in autosegmental terms. If [-emph] does not actually exist, this problem will remain unresolved.

CHAPTER SIX
CONCLUSIONS AND RECOMMENDATIONS

The acoustic findings reported in this study conform with Cohn's comment (1993) that phonetic data is important in gaining insight into phonological analysis. Our acoustic measurements of the second formant frequency values in utterances from Classical and Modern Standard Arabic have shown clearly that the expert and non-expert reciters differ and that within the two groups of speakers the styles also differ. We have also shown that the difference is a continuum whereby the principal difference is manifested acoustically by depressing the second formant of the vowel in emphatic environments. Accordingly, the more expertise the speaker has and the more educated style he follows the lower the second formant frequency value of the vowel. It was further shown that speakers and styles merely differ in respect of the emphatic forms whereas the plain forms remain neutral because plainness, for one reason or another, is not exaggerated. Emphasis forms a scale, so we can talk about a vowel being more or less emphatic, whereas plainness is just plainness and does not get exaggerated in the same way as emphasis does. That would, in turn, lead to the conclusion that emphasis is a single-valued or unary feature in Arabic phonology.

Although the experiment led to the finding that emphasis is likely to be a unary feature it should be noted that we did not explore the phonology of this finding nor could we discuss its implication for the traditional feature analysis of CA segments. Therefore, these problems will be reserved for future studies. But it was shown that the current version of the autosegmental theory does not apparently account for this problem and, consequently, the treatment of emphasis blocking remains problematic.

The notion of the mechanical blocking of emphasis does not fit with the abstractness of the phonology which treats both the spreading and blocking of features as abstract components that underlie speech production. Indeed, our findings regarding the shape of the emphatic gesture, which has an abrupt onset and gradual offset, if it could be supported by empirical evidence in future studies, may further weaken the whole notion of emphatic spreading and gives rise to a phonetic reading of emphasis in *tajwid.*

In this study we addressed the theory of phonetic/surface underspecification which states that segments could remain unmarked for certain features in the phonetic output. The significance of this theory lies in its treatment of certain phonetic data as part of the grammar. Phonologists have started recently to distinguish three kinds of phenomena. There is first the abstract, categorical and symbolic representation that is conventionally known as the phonology. There is also the universal and bio-mechanical sound production which is just the way the human vocal system works, and this is often referred to as the phonetics. It now appears that there is something in between the two, which is language-specific, but cannot be described in terms of abstract categorical distinctions nor in terms of the physical requirements of speech production. These phenomena have been called language-specific phonetic rules. The substance of the new issue is that part of the description of individual languages and styles must involve continuous quantitative data. Language-specific phenomena cannot be expressed exclusively in terms of symbolic categories.

We have attempted to assess the applicability of these assumptions to our acoustic data. The principal question that arose in this study was that whether the vowel in emphatic environments is marked categorically for emphasis or merely exhibits some degree of emphasis through phonetic interpolation. The experts showed asymmetrical emphatic-to-plain and plain-to-emphatic vowel trajectories where the onsets and midpoints were pulled apart and the trajectories crossed during the production of the second half of the vowels. The experts also consistently attained the lowest F2 values in recitation style among all the speakers. Therefore, there exists strong evidence against a purely phonetic reading of emphatic spread and its resistance in CA. Nevertheless, it was indicated that this problem is not yet resolved and that the gradient nature of emphasis could possibly contradict a categorical interpretation of the effect of emphasis on adjacent vowels. It is also important to note that the findings reported in this study do not entail that we totally reject the assumption that underspecification could persist into the phonetics. We only mean that the models offerred under the current version of the theory of surface underspecification fail to account in detail for some of our data.

To conclude the study, we can assume that the analysis of emphatic assimilation and its phonological and phonetic behaviour in Classical Arabic requires more extensive investigation. The autosegmental approach should account for the problems that have not yet been handled appropriately, particularly the blocking of emphasis and its potential role in the grammar and the unarism of emphasis as a phonological feature that has no real negative value. We are not quite sure whether emphatic assimilation is to be considered categorical or gradient. The wide variability of emphasis in different styles, the complicated vocal activities that are involved in emphatic articulation and the way emphasis has been analyzed phonetically and phonologically seem to have all contributed to the problem.

Since it has become clear that *tajwid* is essentially a phonetic and phonological subject we recommend that recitation rules be studied experimentally so to investigate some unexplored differences between speakers and styles from different categories and not necessarily the ones covered in this study. It might be interesting to study other recitation models as well. There would remain several rules to investigate in greater depth such as points of articulation, feature analysis and nasal assimilation. This study was primarily acoustic. It might be worthwhile to carry out instrumental articulatory studies of recitation style(s) so as to judge the validity and scope of the impressionistic judgments of the early scholars. We expect that further studies of *tajwid* from a modern perspective would bring into light a number of problems of a potential interest to phonologists and phoneticians particularly those interested in the phonology-phonetics interface.

APPENDIX I
TEST TOKEN

The target CVC strings analyzed acoustically are printed in **bold**. Most pairs are identical and the rest are similar.

(i) PP vowel context

No	CA	Meaning	No	MSA	Meaning
1	bi**yad**ih	with his hand	1	wa**yadi**	and his hand
2	^{c}**adh**ānan	Torture	2	^{c}**adh**āban	torture
3	wa^{c}**asā**	and it may be	3	Wa^{c}**asā**	and it may be
4	**'atā**ka	he came to you	4	**'atā**ka	he came to you
5	**'ahq**āba	Ages	5	**'ahq**āba	ages
6	**wa**^{c}aṣā	and he disobeyed	6	**wa**^{c}aṣā	and he disobeyed
7	**ba**^{c}ūḍatan	a gnat	7	**ba**^{c}ūḍah	a gnat
8	'aṣwā**tak**um	your voices	8	'aṣwā**tak**um	your voices

(ii) EE vowel context

No	CA	Meaning	No	MSA	Meaning
1	**ghar**aqā	with violence	1	**ghar**qā	with violence
2	**ṭagh**ā	He exceeded bounds	2	**ṭagh**ā	He exceeded bounds
3	sha**qaq**nā	We split (it)	3	sha**qaq**nā	We split (it)
4	'akh**araq**tahā	Did you scattle it?	4	'akh**araq**tah	Did you scattle it?
5	qa**ṣaṣ**ā	following their tracks	5	qa**ṣaṣ**ā	following theor trackes
6	**barar**ah	pious and just	6	**barar**ah	pious and just
7	wa-agh**raq**na	and We drowned	8	wa-agh**raq**na	and we drowned

(iii) EP vowel context

No	CA	Meaning	No	MSA	Meaning
1	bi**danīn**	withhold grudgingly	1	bi**danīn**	withhold grudgingly
2	**dhah**ara	(it) appeared	2	**dhah**ara	(it) appeared
3	**ṣabara**	(they/he) pateiently preserved	3	**ṣabara**	(they/he) pateiently preserved
4	**ṭaba**qan	stage/layer	4	**ṭaba**qan	stage/layer
5	#tta**khadha**	(he) took/followed	5	itta**khadha**	(he) took/followed
6	wala**qad**	it was/had been	6	wala**qad**	it was/had been
7	**rabb**ahū	His Lord	7	**rabb**ahū	His Lowrd
8	wa**ghawwā**ṣ	and a diver	8	**ghawwā**ṣ	diver

(iv) PE vowel context

No	CA	Meaning	No	MSA	Meaning
1	**'adā**'at	it lighted	1	**'adā**'atil	it lighted
2	**'adh**lama	it became dark	2	**'adh**lama	it became dark
3	wa^{c}**aṣ**ā	And he disobeyed	3	wa^{c}**aṣ**ā	And he disobeyed
4	**ba**ṭan	hidden	4	**ba**ṭan	hidden
5	muṭah**har**ah	pure	5	muṭah**har**ah	pure
6	yunf**akhu**	(it is) blown	6	yun**fakhu**	(it is) blown
7	**wagh**assāqā	and murky	7	**wagh**assāqā	and murky
8	**fa**qāla	and he said	8	**fa**qāla	and he said

APPENDIX II
CLASSICAL FEATURES

(i): Consonants

Feature	ʔ	h	ʕ	ħ	ʁ	χ	q	k	j	ʃ	j	d	l	n	r	ṭ	d	t	ð̣	ð	θ	ṣ	s	z	f	w	b	m
majhūr	+	-	+	-	+	-	+	-	+	-	+	+	+	+	+	+	+	-	+	+	-	-	-	+	-	+	+	+
mahmūs	-	+	-	+	-	+	-	+	-	+	-	-	-	-	-	-	-	+	-	-	+	+	+	-	+	-	-	-
shadīd	+	-	-	-	-	-	+	+	+	-	-	-	-	-	-	+	+	+	-	-	-	-	-	-	-	-	+	-
bayna bayn	-	-	+	-	-	-	-	-	-	-	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	+
rikhw	-	+	-	+	+	+	-	-	-	+	+	+	-	-	-	-	-	-	+	+	+	+	+	+	+	+	-	-
mustaᶜli	-	-	-	-	+	+	+	-	-	-	-	+	-	-	-	+	-	-	+	-	-	+	-	-	-	-	-	-
mustafil	+	+	+	+	-	-	-	+	+	+	+	-	+	+	+	-	+	+	-	+	+	-	+	+	+	+	+	+
muṭbaq	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	+	-	-	+	-	-	+	-	-	-	-	-	-
munfatih	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	-	+	+	-	+	+	-	+	+	+	+	+	+
dhalaqiyy	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	-	-	-	-	-	-	-	-	-	+	-	+	+
muṣmat	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-	+	+	+	+	+	+	+	+	+	-	+	-	-
ṣafīriyy	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	-	-	-	-
muqalqal	-	-	-	-	-	-	+	-	+	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	+	-
layyin	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
mukarrar	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-
mutafashshī	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
mustaṭīl	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
munharif	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-
aghann	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	+

(ii): Vowels

	kasrah/ *yāʾ*	*fathah/ alif*	*ḍammah/ wāw*
Feature	i(:)	a(:)	u(:)
majhūr	+	+	+
mahmūs	-	-	-
shadīd	-	-	-
bayna bayn	-	-	-
rikhw	+	+	+
mustaᶜli	-	-	-
mustafil	+	+	+
muṭbaq	-	-	-
munfatih	+	+	+
dhalaqiyy	-	-	-
muṣmat	+	+	+
ṣafīriyy	-	-	-
muqalqal	-	-	-
layyin	-	-	-
mukarrar	-	-	-
mutafashshī	-	-	-
mustaṭīl	-	-	-
munharif	-	-	-
aghann	-	-	-

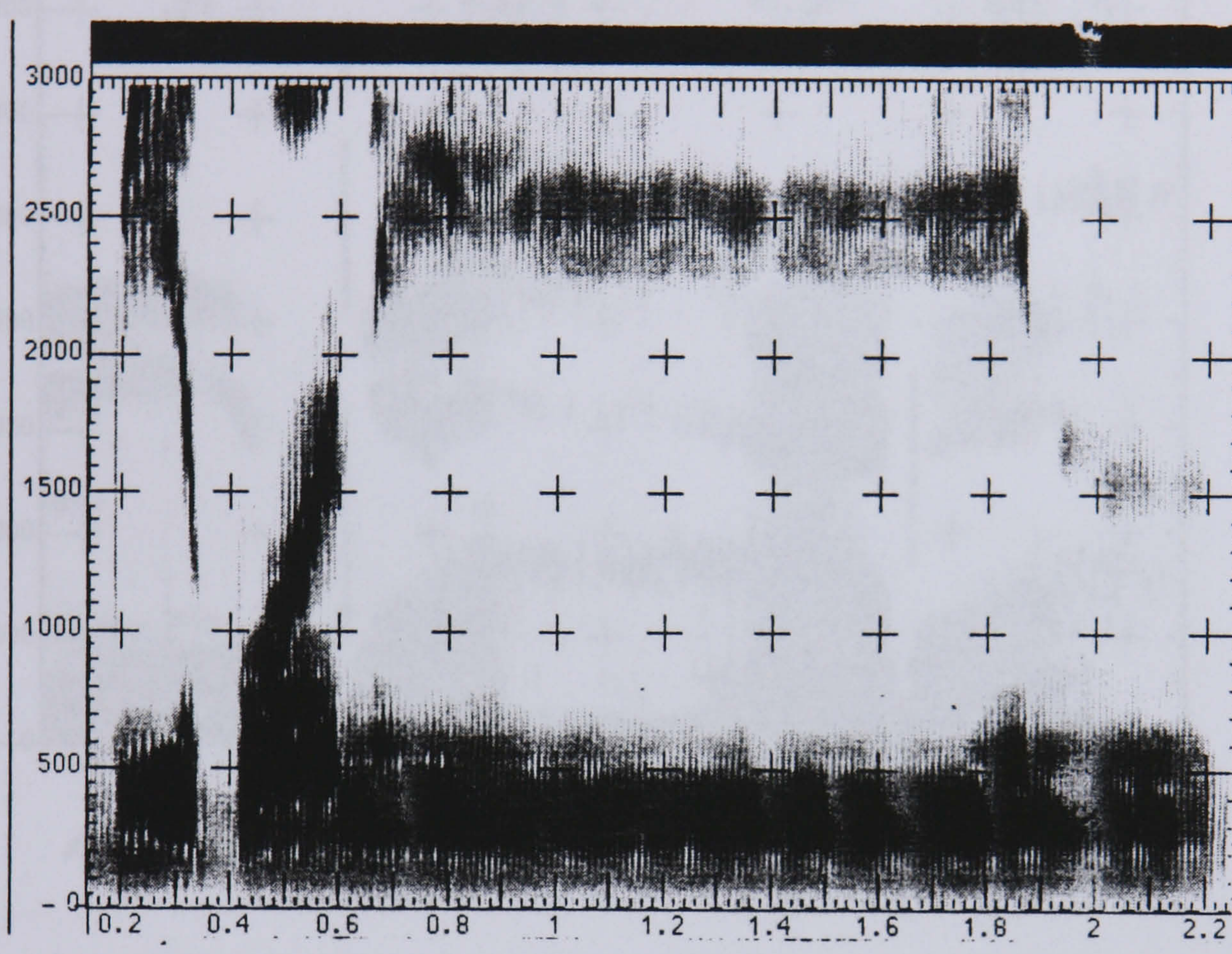
APPENDIX III

MAJOR RECITERS OF THE *QUR'AN* SINCE THE SEVENTH CENTURY

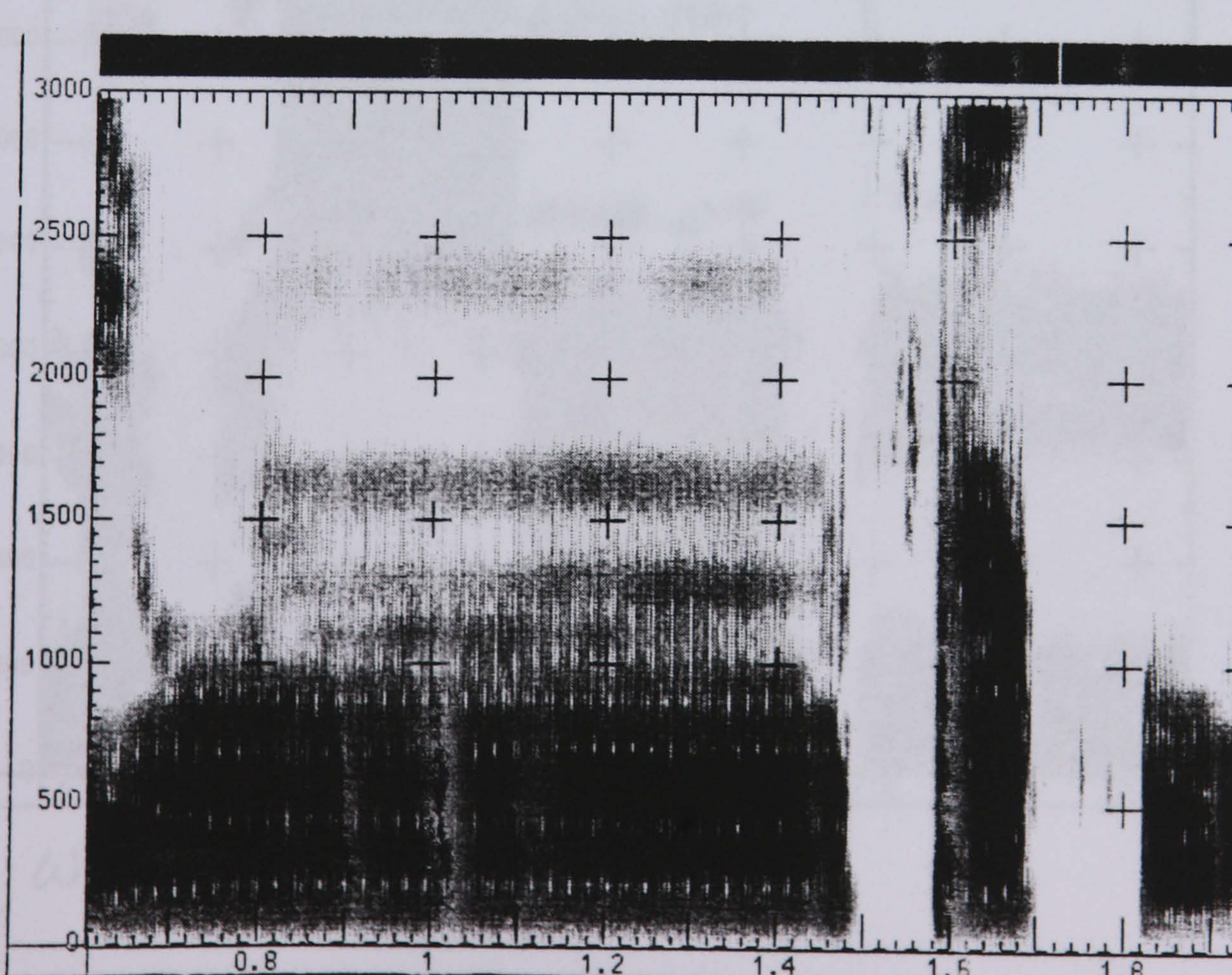
NO	NAME OF RECITER	DIED IN	CITY	PROVINCE
1	Nafi^{c} Al-Madani	785	Madīnah	Hejaz
2	Ibn Kathīr Al-Makki	738	Makkah	Hejaz
3	Abu ^{c}Amr bin Al-^{c}Alā'	771	Baṣrah	Iraq
4	^{c}Abdullāh bin ^{c}Amir	736	Dimashq	Bilad Al-Sham
5	Hamzah Al-Zayyāt	773	Kūfah	Iraq
6	^{c}Aṣim bin Abi-Al-Najūd	774	Kūfah	Iraq
7	^{c}Ali Al-Kisā'I	805	Madīnah	Hejaz
8	Yazīd Al-Qi^{c}qā^{c}	747	Madīnah	Hejaz
9	Ya^{c}qūb Al-Haḍrami	820	Baṣrah	Iraq
10	Khalf bin Hāshim	843	Kūfah	Iraq
11	Al-Hasan Al-Baṣrī	1408	Baṣrah	Iraq
12	^{c}Abdul-Raḥmān bin Muḥaysin	1320	Makkah	Hejaz
13	Sulaymān Al-Al-A^{c}mash	1345	Kūfah	Iraq
14	Yaḥya Al-Yazīdi	1397	Baṣrah	Iraq

APPENDIX IV

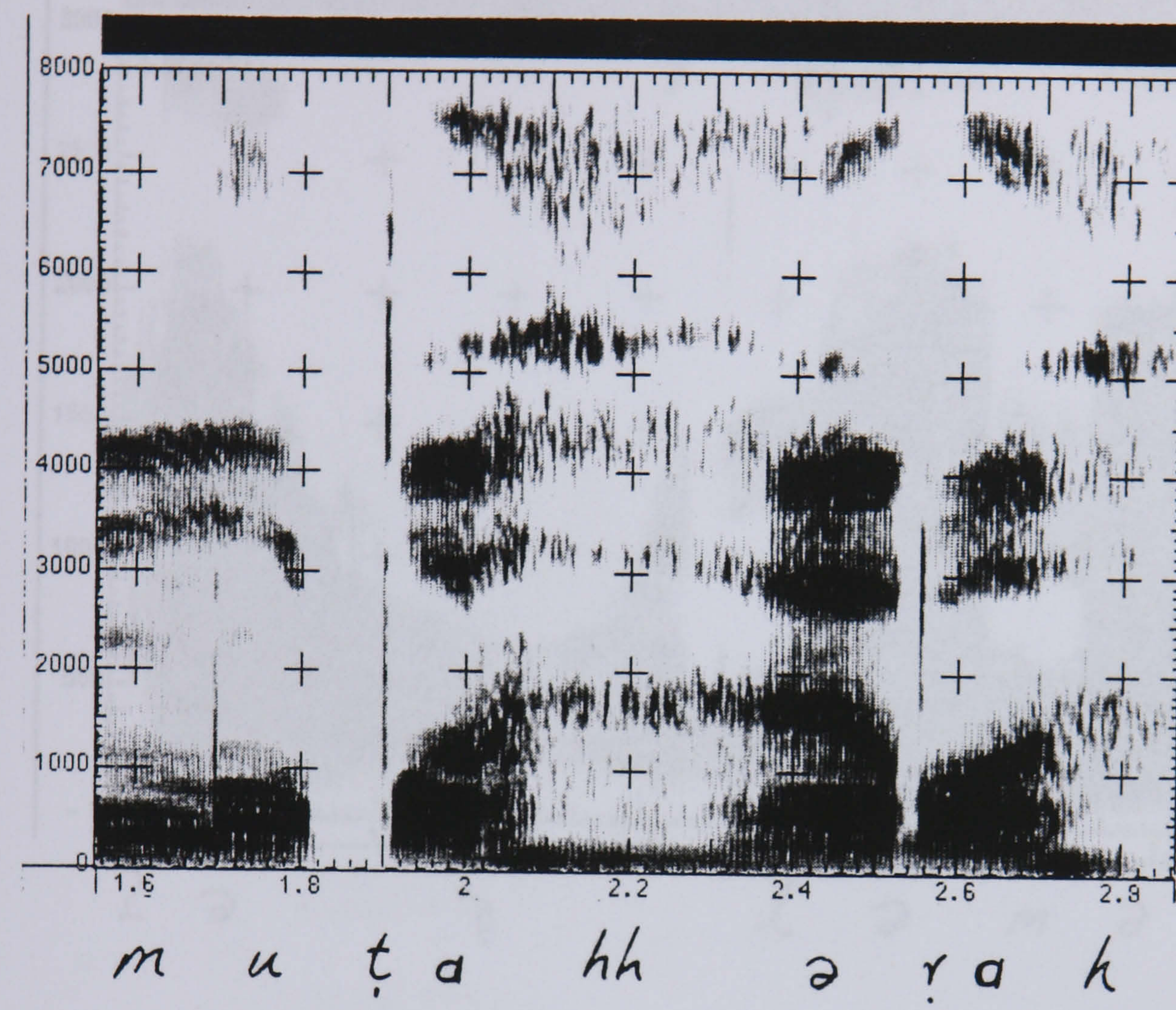
ADDITIONAL SPECTROGRAMS OF AN EXPERT RECITER

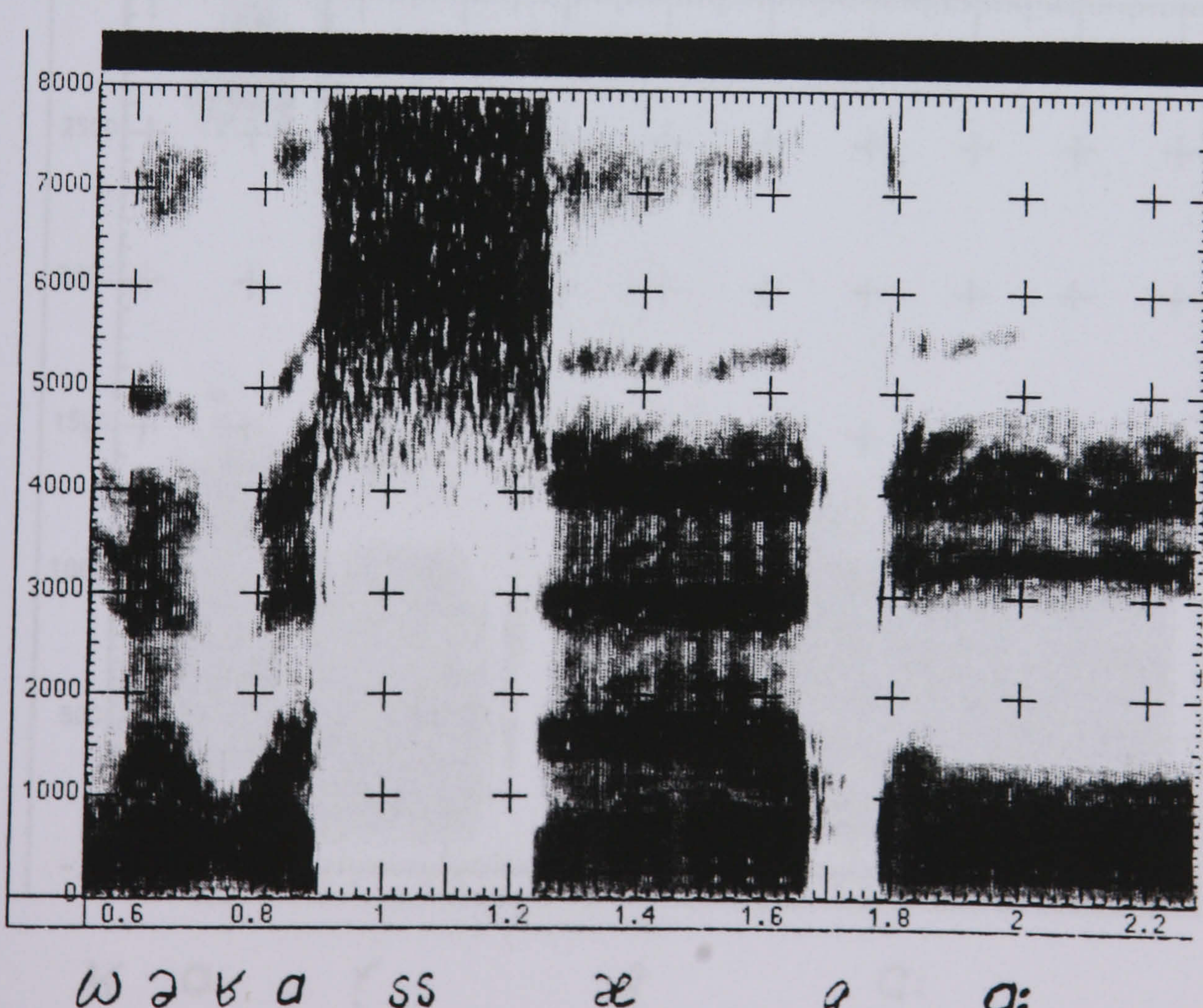


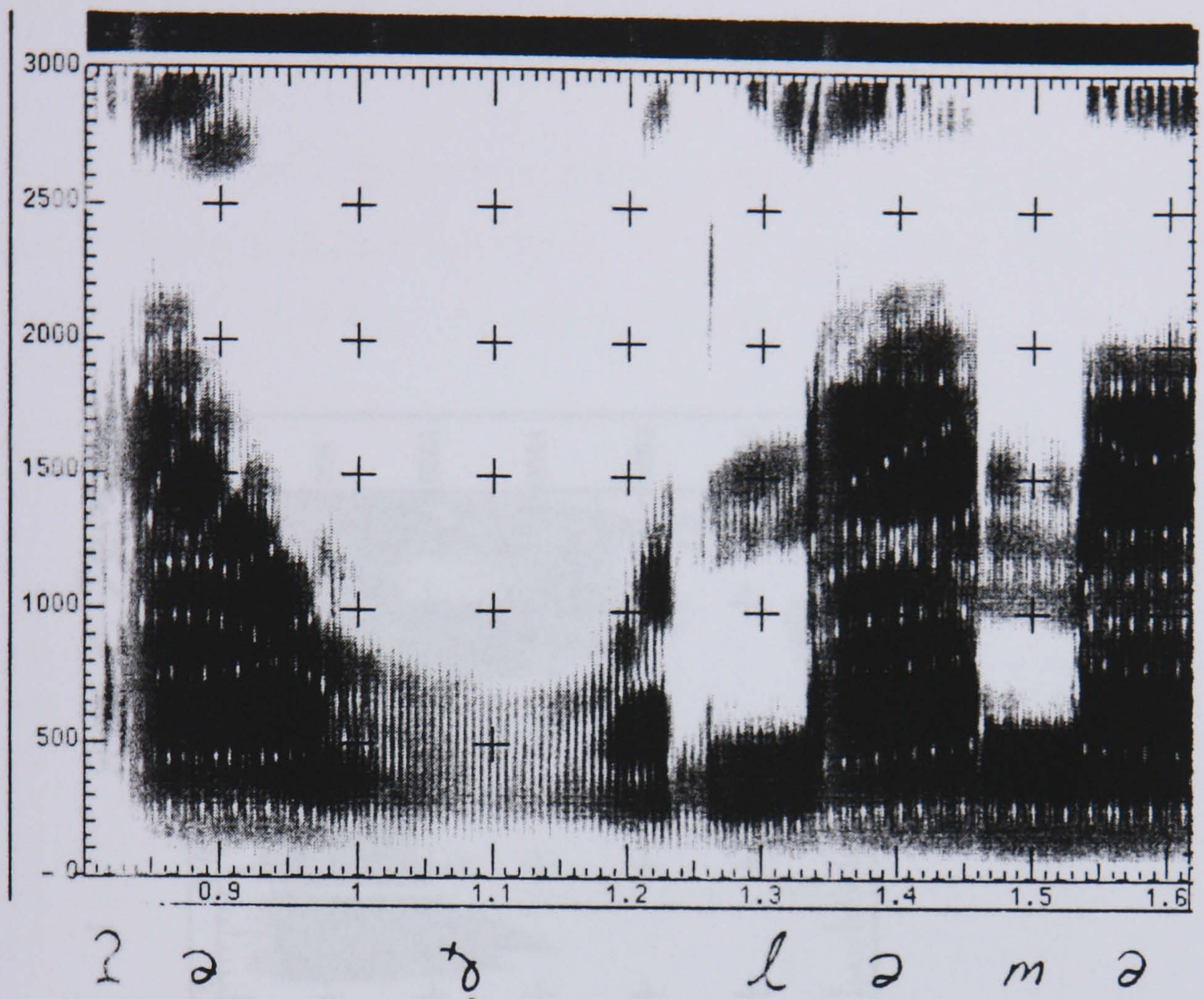
b i ḍ a n i: n

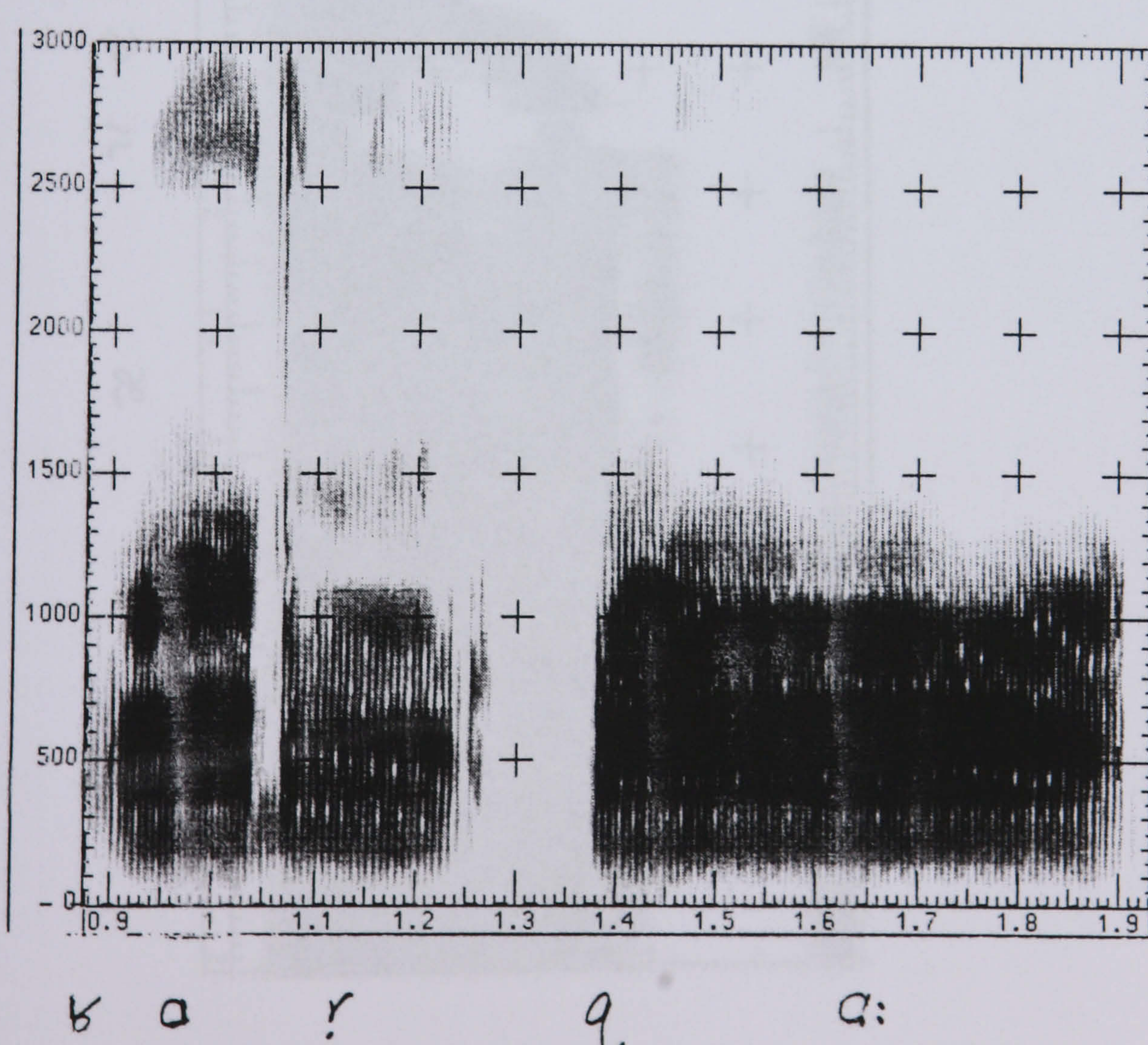


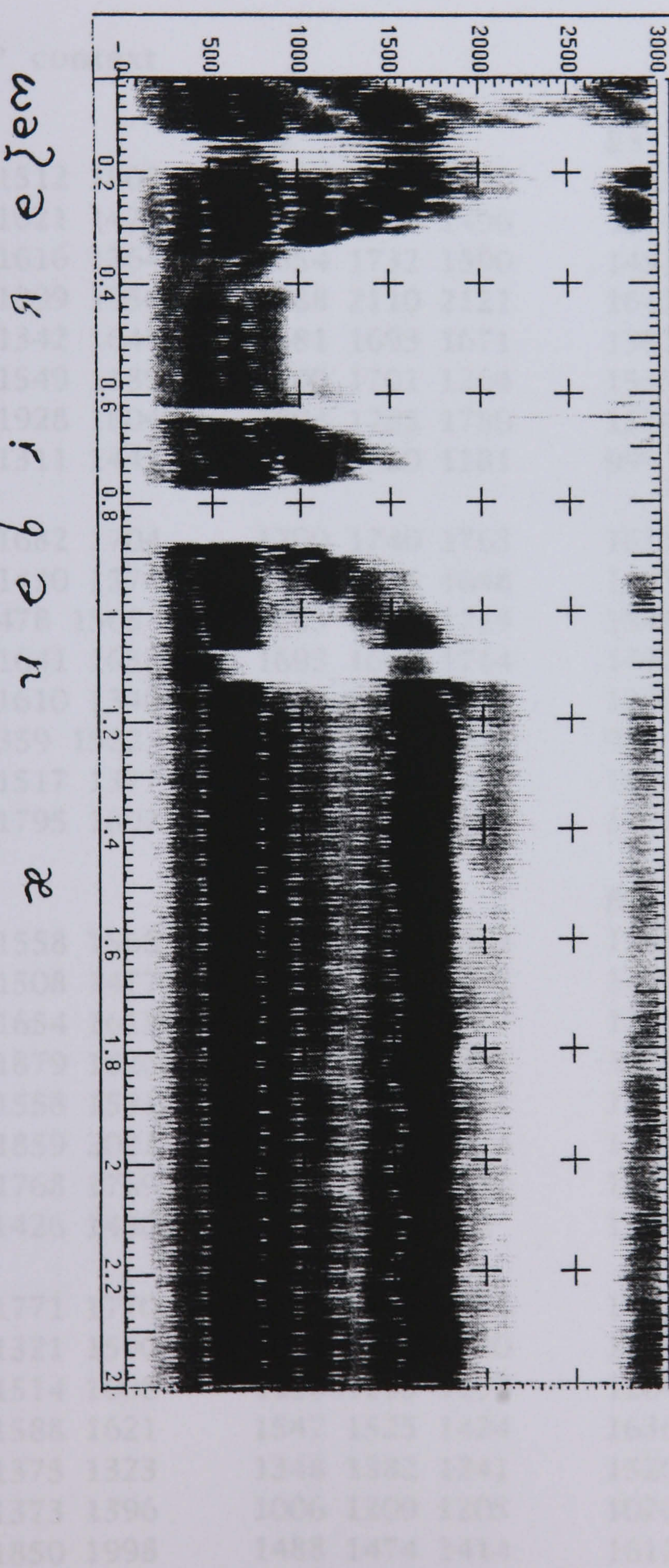
j ã(n) f ə x u


8000
7000
6000
5000
4000
3000
2000
1000
0
1.6
1.8
2
2.2
2.4
2.6
2.8
m u ṭ a hh ə ṛ a h


8000
7000
6000
5000
4000
3000
2000
1000
0
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
w ə ʁ a ss æ q a:


3000
2500
2000
1500
1000
500
0
0.9
1
1.1
1.2
1.3
1.4
1.5
1.6
ʔ ə ɖ l ə m ə


3000
2500
2000
1500
1000
500
0
0.9
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
ʁ a ɾ q a:


500
1000
1500
2000
2500
3000
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2

APPENDIX V

APPENDIX V

F2 MEASUREMENTS OF /a/: RAW DATA

The first eight lines for each speaker indicate CA measurements and the rest indicate MSA measurements (vowel's onset, mid and offset). The lists are divided according to contexts: PP, EE, EP & PE.

(i) PP context

E1	E2	E3
1481 1512 1609	1538 1633 1530	1433 1513 1600
1510 1621 1421	1393 1596 1496	1300 1328 1332
1523 1616 1764	1654 1732 1590	1453 1595 1726
1828 1899 1956	2088 2110 2121	1648 1615 1777
1355 1342 1647	1681 1693 1671	1387 1359 1595
1733 1549 1189	1700 1701 1264	1535 1425 1272
1678 1928 1804	1804 1785 1780	1526 1514 1509
1098 1311 1443	1284 1320 1181	999 1215 1412
1627 1682 1704	1700 1740 1763	1611 1553 1559
1135 1430 1574	1545 1646 1648	1441 1509 1476
725 1478 1505	1613 1676 1719	1545 1601 1595
1658 1641 1652	1693 1666 1714	1442 1441 1592
1501 1610 1346	1414 1609 1470	1230 1391 1394
890 1359 1522	1085 1458 1331	951 1257 1367
1541 1517 1377	1655 1650 1474	1615 1518 1514
1907 1795 1892	2131 2122 2001	1766 1740 1704

E4	E5	E6
1588 1558 1568	1539 1503 1484	1585 1540 1700
1440 1508 1477	1282 1528 1262	1489 1433 1154
1593 1654 1613	1112 1197 1197	1251 1507 1756
1960 1879 1820	1805 1665 1697	1857 1769 1881
1438 1558 1531	1200 1165 1151	1182 1254 1582
1746 1859 2021	1485 1436 1324	1759 1579 1266
1741 1768 1769	1579 1534 1490	1662 1705 1753
1155 1426 1430	891 1171 1012	1274 1236 1145
1751 1771 1770	1512 1511 1552	1781 1787 1723
1238 1321 1590	1210 1317 1420	1384 1571 1651
1409 1514 1608	1059 1213 1199	1264 1542 1729
1606 1588 1621	1547 1525 1424	1636 1651 1795
1473 1375 1323	1348 1382 1241	1520 1546 1226
1061 1373 1396	1006 1209 1205	1026 1404 1432
1721 1850 1998	1488 1474 1414	1612 1576 1444
2014 1919 1795	1760 1710 1652	1938 1893 1878

N1

1486	1389	1285
1250	1311	1382
1428	1537	1811
2023	1925	1875
1441	1509	1577
1658	1622	1409
1610	1602	1776
1043	1102	1140
1456	1543	1696
1557	1679	1685
1475	1557	1682
1306	1369	1578
1189	1298	1343
901	1106	1251
1484	1433	1285
1929	1874	1932

N2

1451	1462	1482
1105	1250	1267
1582	1668	1779
2308	2013	2051
1447	1526	1660
1594	1466	1298
1644	1636	1785
1122	1225	1286
1583	1650	1676
1550	1585	1712
1132	1393	1492
1540	1588	1732
1278	1317	1364
871	1225	1268
1563	1577	1539
2280	2006	2105

N3

1264	1333	1181
1175	1191	983
1090	1457	1492
2004	1688	1933
1357	1328	1585
1472	1371	1265
1504	1527	1617
1022	1023	1025
1541	1581	1632
1187	1402	1492
1020	1389	1602
1380	1291	1420
1281	1302	1002
1099	1059	1072
1406	1510	1101
1654	1713	1728

N4

1389	1402	1463
1175	1330	1168
1445	1538	1602
1866	1871	1806
1481	1600	1560
1388	1363	1197
1830	1640	1698
1211	1163	1147
1496	1556	1700
1417	1620	1720
999	1284	1402
1410	1441	1718
1111	1355	1368
805	1012	1185
1476	1461	1390
1852	1831	1860

N5

1456	1467	1507
1231	1365	1238
1360	1508	1559
1603	1687	1724
1448	1477	1504
1653	1500	1541
1532	1509	1658
1222	1133	961
1542	1539	1725
1394	1444	1533
1385	1467	1593
1505	1433	1526
1255	1391	1280
967	1220	1326
1464	1464	1182
1707	1710	1685

N6

1542	1558	1668
1512	1572	1382
1455	1702	1711
2148	2038	2005
1417	1439	1575
1765	1639	1334
1799	1784	1819
1162	1182	1409
1617	1635	1640
1466	1502	1598
1767	1599	1708
1565	1612	1710
1597	1652	1543
1037	1362	1452
1703	1593	1504
1887	1848	1844

N7

1391	1321	1370
1527	1582	1373
1277	1552	1619
1789	1734	1733
1054	1237	1493
1614	1551	1407
1563	1558	1652
949	1139	1290

N8

1529	1573	1538
1594	1590	1162
1213	1648	1629
1873	1829	1830
1280	1583	1526
1612	1553	1484
1650	1635	1594
1127	1205	1100

N9

1684	1700	1886
1345	1491	1472
1569	1650	1820
1965	1880	1934
1473	1556	1593
1725	1621	1304
1693	1680	1815
893	1372	1595

1602 1626 1739	1588 1640 1625	1776 1845 1860
1146 1309 1485	1139 1591 1557	1384 1651 1755
1121 1379 1674	1323 1639 1708	1583 1799 1934
1501 1542 1640	1578 1473 1621	1664 1686 1712
1584 1394 1194	1432 1555 1250	1367 1484 1450
950 1262 1275	705 1291 1258	872 1278 1454
1650 1665 1650	1640 1597 1658	1667 1540 1323
1863 1762 1774	1992 1914 1766	2137 2101 2124

(ii) EE context

E1	E2	E4
892 981 841	1063 1136 1026	1026 1082 1069
890 989 989	943 1065 1049	1019 1057 1030
926 1072 870	941 1128 1189	963 976 990
803 894 920	931 1008 741	876 925 818
952 1007 1057	975 1097 903	1033 1065 1033
904 983 904	1059 1104 1081	944 1055 1131
755 846 787	866 988 978	897 905 828
910 939 894	987 1140 1046	1033 1001 1063
907 979 914	1049 1075 990	1247 1209 1168
971 908 948	1007 947 988	1181 1097 1082
936 999 872	961 1059 1025	1068 1096 1063
979 1014 978	1030 1171 1120	1188 1179 1199
943 1121 1222	1211 1200 1038	895 1170 1196
966 1046 1007	1150 1204 988	1163 1174 1188
930 1017 1046	902 1127 1146	1160 1209 1088
1033 1012 907	993 1095 1008	1049 1077 1059

E4	E5	E6
1030 1120 777	880 936 795	1007 1137 947
848 1095 1175	771 949 845	961 1179 936
861 1031 978	959 1008 951	1104 1147 676
837 1004 948	885 711 843	844 941 849
884 763 706	1105 1002 934	1044 1105 1015
1035 1099 1130	871 930 898	987 1014 936
638 827 861	767 847 844	827 929 913
770 997 937	877 914 893	900 859 915
1161 1265 1253	901 910 939	1124 1111 899
932 1057 1139	846 993 974	964 1024 884
926 1138 765	856 940 854	1003 1021 924
947 1260 1121	1371 1308 1093	1088 1020 986
1046 1084 933	933 999 939	992 1133 1003
1009 1020 889	928 1014 942	1071 1157 1054
927 1086 1171	817 1067 964	986 1171 1064
710 1057 1026	835 933 955	989 908 945

N1

1148 1304 1164
1060 1131 1063
1065 1064 1057
1005 1010 898
1135 1103 1025
1046 1013 867
814 1053 1042
1035 1116 948

1129 1070 1088
1259 1245 1169
877 1000 1138
1152 1205 1125
1119 1120 1064
955 1183 1219
1098 1213 1170
880 1001 992

N2

1198 1178 1155
1261 1203 1191
1297 1244 1226
1168 1185 1176
1263 1193 1114
1217 1201 1249
1036 1102 1034
1581 1503 1528

1139 1104 1045
1441 1398 1405
1153 1201 1245
1589 1530 1488
1330 1297 1223
1221 1200 1141
1222 1221 1447
1168 1197 1077

N3

1652 1458 1150
953 1060 1098
858 1048 1123
896 947 964
880 1011 885
648 796 1135
952 1042 931
1040 966 1075

1595 1408 1203
1029 1202 1262
994 1053 1035
1068 1097 953
1101 941 1016
981 1039 935
1098 1213 1241
1039 1173 967

N4

1185 1193 1195
1176 1213 1185
1118 1198 1243
1019 1037 1083
1257 1265 1196
1142 1120 999
863 1038 1046
1042 1237 1179

1265 1248 1232
1004 1188 1234
1018 1088 1064
1057 1232 1227
1085 1177 1188
1109 1174 1214
1247 1200 1183
1028 1207 1186

N5

1048 1145 1081
966 1099 1096
890 982 1065
835 848 898
788 958 931
862 967 918
830 975 980
889 919 943

1089 1099 1087
919 881 879
922 869 821
926 900 780
783 1013 1095
840 951 973
1038 1074 956
906 1051 1036

N6

1145 1224 1162
1272 1096 1204
988 907 961
787 895 885
1286 1291 994
1216 1189 1298
732 1047 1116
1031 1069 986

1102 1089 1271
930 1110 1121
841 975 741
934 734 1107
1032 1157 1018
1122 1039 1034
1010 1058 1155
995 1153 1157

N7

911 1109 1043
1104 1196 1020
967 962 941
937 1014 891
1046 1186 1047
1029 1101 1116
915 1078 967
1023 1043 1072

N8

1076 1127 1080
936 1127 1109
931 1111 1039
1008 986 926
1006 1075 1026
1005 1052 909
866 1017 992
884 1105 1103

N9

1069 1147 1023
965 1174 1122
967 1104 1043
1089 1001 1101
1051 1277 1002
890 931 1027
823 889 815
1071 1084 1158

1002 1109 1049	113 1186 1140	1181 1049 1157
972 1012 1018	819 1076 1103	1091 1374 1173
1065 1088 988	942 1018 959	1084 1111 1085
1096 1071 1106	959 1101 1159	1212 1357 1257
1077 1182 1090	1146 1187 1184	1357 1514 1330
1021 1180 1067	1047 1089 1031	1166 1217 1173
960 1038 1213	997 1148 1093	1116 1206 1210
894 976 903	982 1165 1011	1059 1151 1017

(iii) EP context

E1	E2	E3
948 1117 1447	849 1003 1006	928 1037 1222
925 1153 1497	1088 1305 1717	996 1166 1545
919 1065 1096	954 1146 1223	990 1015 1089
945 893 818	1176 1159 1064	908 908 985
980 1191 1454	1079 1326 1575	1078 1337 1469
881 961 1881	830 1025 1711	859 1034 1580
810 806 980	959 1163 1030	981 987 935
809 952 1200	738 1032 1255	998 1039 1027
924 983 940	810 935 1190	970 1085 1082
938 978 849	1002 1045 1054	1092 968 757
979 1143 1505	1659 1512 1235	1206 1275 1375
812 1109 1837	839 1086 1679	1076 1165 1598
901 887 1058	820 1190 1074	1068 953 866
956 903 1014	939 1112 1178	1070 1128 1214
896 1004 1004	915 1058 835	949 1115 1015
942 1203 1589	1085 1261 1684	1114 1344 1494

E4	E5	E6
880 1107 1115	630 906 1138	881 1107 1192
951 1130 1482	955 1025 1399	1006 1253 1620
864 1085 1382	825 1083 1121	743 902 1110
763 893 1101	812 1044 867	985 1069 934
993 1279 1550	757 1038 1565	1034 1273 1607
620 1203 1676	711 984 1498	823 1118 1825
816 742 860	673 765 800	781 894 993
604 970 1209	671 934 865	930 1075 1085
559 899 1264	806 880 888	723 901 973
876 1049 791	964 1017 995	1072 1041 971
1163 1338 1479	1104 1323 1435	966 1172 1484
1098 1145 1472	764 923 1560	813 1095 1754
1128 1151 1331	889 989 1052	850 1103 991
748 1248 1334	717 875 1044	781 1090 1568
634 692 911	877 943 867	877 979 1024
1081 1406 1578	967 1126 1385	1043 1488 1845

N1

687 928 1044
1340 1402 1568
948 1151 983
1122 1050 897
1094 1283 1559
696 1059 1589
1061 1093 1161
853 1054 964

906 993 903
1111 1012 889
1279 1302 1405
814 1246 1596
1038 1120 965
830 986 1242
1125 1166 932
1180 1552 1761

N2

914 1121 1178
1417 1491 1553
1247 1302 1076
987 1197 1172
1070 1186 1575
1124 1190 1369
1459 1346 1126
1142 1192 1165

980 1084 963
1163 1143 800
1557 1599 1483
1073 1266 1531
1115 1155 1131
1045 1138 1215
1547 1520 1282
1221 1397 1736

N3

794 1024 1026
1380 1447 1529
1006 1108 1056
1016 909 861
1032 1116 1304
953 981 1670
763 875 893
953 1039 1241

1135 1268 1407
1078 1000 636
1474 1472 1374
1120 1313 1570
1126 1010 953
937 1004 1197
1126 1122 1044
1012 1219 1519

N4

797 852 1172
1511 1459 1433
999 1097 1026
1167 1056 950
1317 1382 1455
1153 1471 1693
1038 1132 1054
1062 1173 1009

917 1101 943
1194 1047 808
1500 1456 1338
925 1482 1806
1056 1123 996
805 1139 1213
1051 1084 931
1286 1619 1665

N5

871 980 1085
1407 1313 1393
957 1052 1180
884 900 764
948 1053 1351
632 973 1539
775 916 938
865 1000 1099

863 991 952
954 829 600
1323 1395 1429
747 1067 1481
962 1037 974
838 1019 1122
773 888 882
1076 1299 1556

N6

775 983 920
956 1407 1626
757 1087 1108
1065 1009 982
1287 1407 1688
843 991 1662
1149 1214 1336
815 994 1229

820 1073 1147
1110 1174 902
1488 1567 1612
805 1245 1665
911 1091 1147
989 1043 1106
936 1142 1230
1177 1497 1805

N7

893 1082 1296
1008 1284 1502
989 1142 1253
1040 1175 1039
992 1237 1523
996 993 1562
967 1058 1156
896 1102 1379

N8

848 1043 1229
1070 1265 1519
955 1108 1134
1046 1193 1156
1122 1237 1339
1058 1094 1594
923 1023 980
902 1061 1122

N9

835 1020 1136
1084 1313 1644
1011 1042 1086
1064 1103 1103
893 1360 1766
1017 1284 1690
959 1028 1046
1013 1059 1259

879 1111 1075	920 985 1001	1092 1193 1134
1117 1089 1023	1137 1161 995	1030 1185 1024
1013 1169 1406	1352 1535 1454	1449 1582 1689
906 1026 1576	864 1153 1630	1067 1261 1661
965 1101 1116	949 1084 1098	1038 1054 1050
835 1062 1113	847 1131 1316	955 1085 1030
1081 1113 1046	1035 1092 1016	1208 1286 1147
950 1141 1561	1084 1243 1432	1242 1552 1754

(iv) PE context

E1	E2	E3
1330 1280 963	1405 1377 1173	1214 1240 1134
1170 1089 864	1056 1286 968	1038 1102 975
1384 1334 871	1612 1530 989	1396 1306 886
1565 1254 849	1504 1210 994	1393 1320 1029
1360 1350 1050	1324 1213 996	1240 1224 939
1278 1111 985	1102 1202 1156	1390 1278 1112
1425 1330 969	1432 1349 1007	1313 1275 1100
1603 1255 1043	1203 1358 1152	1324 1254 1100
1385 1385 1046	1235 1162 1043	1180 1146 1082
1519 1305 1118	1231 1253 1070	1363 1292 1164
1332 1209 1011	1393 1258 1071	1233 1191 1102
899 896 962	952 1046 1050	915 956 1018
1317 1264 1021	1254 1276 1158	1227 1216 1116
1487 1295 1001	1388 1320 1008	1302 1178 1064
1630 1212 1060	1389 1324 1283	1260 1201 1200
1361 1101 874	1209 1062 886	1335 1240 1110

E4	E5	E6
1503 1459 1113	1257 1285 1119	1477 1463 1040
1201 1370 1078	922 1054 1010	978 1248 1054
1474 1530 1213	1516 1293 855	1687 1343 739
1610 1265 736	1438 985 677	1703 1502 937
1621 1639 1131	1249 913 612	1448 1356 833
1360 1389 1126	884 1106 930	1227 1189 1154
1426 1458 1215	1318 1291 959	1360 1343 1016
1647 1590 1191	1537 1362 909	1442 1220 1104
1198 1247 1247	1297 1202 1043	1517 1439 1009
1347 1361 1263	1203 1079 932	1303 1140 1053
1441 1375 1189	1415 1273 1111	1546 1442 1043
1095 1207 1146	862 1054 847	1077 1202 1036
1360 1355 1085	1147 1049 786	1497 1365 1176
1567 1337 1269	1494 1265 931	1578 1259 974
1747 1583 1399	800 874 1055	1338 1133 787
1415 1253 1213	1251 1021 864	1409 1204 885

N1	N2	N3
1105 1169 986	1225 1208 1150	1079 941 999
1007 1156 1058	942 1172 1079	981 1010 953
1351 1247 857	1346 1241 1080	1267 1090 764

1508 1191 851
923 1027 1040
1138 1108 1047
1312 1280 1044
1167 1133 1118

1082 1100 951
1230 1165 1102
1176 1184 1028
1099 1230 1013
918 1007 1037
1096 899 779
1175 1164 1131
1157 997 765

1246 1155 1068
1095 1186 1118
1256 1270 1284
1189 1144 1032
1388 1395 1547

1207 1243 1213
1258 1267 1299
1198 1155 1084
1116 1119 1182
1077 1121 1116
1169 1170 978
1426 1506 1522
1189 1150 942

1190 1066 890
632 1074 938
1092 1001 1080
1175 1063 963
1195 955 1039

1158 1014 939
1039 981 952
1267 1221 989
1063 1195 1502
837 924 1010
1044 760 997
1171 1097 1068
1069 1050 1026

N4
983 1104 981
1012 1198 1164
1269 1101 888
1328 1225 953
965 1047 866
1211 1176 1158
1154 1134 1122
1217 1211 1220

1080 1085 905
1202 1200 1107
1127 1134 1127
1125 1223 1184
962 1102 962
1138 1028 898
1163 1157 1221
1213 1161 908

N5
1364 1338 1190
1119 1259 1195
1323 1202 742
1468 1296 960
957 1032 859
1223 1062 961
1267 1250 1163
1328 1241 1116

1080 1074 1067
1362 1203 1047
1199 1166 1119
773 1086 1194
851 1020 1016
1055 937 718
1111 1060 1048
1107 1083 970

N6
1614 1612 1161
1230 1379 1199
1564 1229 982
1542 1100 883
1361 1381 953
1377 1145 931
1485 1434 897
1408 1307 1300

1318 1462 1286
1366 1247 1059
1389 1304 1072
918 1077 1194
1284 1315 998
1268 1077 884
1391 1218 1323
1315 1205 1018

N7
1313 1332 1101
991 1245 1078
1286 1072 914
1397 1105 814
1450 1398 902
1300 1292 813
1326 1407 1210
1542 1297 916

1244 1246 1131
1191 1186 1062
1208 1218 1082
932 1145 1074
1448 1196 1102
1156 1019 844
1669 1369 1102
1221 1111 839

N8
1560 1563 1251
952 1320 1105
1393 1201 1070
1369 1092 845
1263 1486 1061
1318 1208 1053
1502 1371 1135
1637 1377 1065

1192 1279 1187
1166 1196 1031
1337 1226 1153
761 1102 1136
1049 1103 1070
1144 1071 959
1356 1237 1163
1155 1114 883

N9
1395 1163 1044
1173 1210 1075
1227 1093 886
1530 1243 1130
1139 1039 998
1498 1059 982
1229 1203 1031
1345 1283 1100

1113 1056 1166
1450 1355 1255
1349 1220 1072
962 1081 1131
1237 1385 1196
1438 1256 1181
1439 1341 1301
1161 1049 1055

APPENDIX VI
ADDITIONAL MATERIAL

Spr	Style	Mean	Spr	Style	Mean
E1	CA	1575	N1	CA	1492
	MSA	1502		MSA	1483
E2	CA	1639	N2	CA	1531
	MSA	1646		MSA	1542
E3	CA	1460	N3	CA	1361
	MSA	1492		MSA	1369
E4	CA	1628	N4	CA	1473
	MSA	1553		MSA	1435
E5	CA	1362	N5	CA	1438
	MSA	1390		MSA	1447
E6	CA	1484	N6	CA	1600
	MSA	1583		MSA	1601
	G.M*		N7	CA	1395
	CA	1523 (106)		MSA	1490
	MSA	1528 (88)			
			N8	CA	1484
				MSA	1522
			N9	CA	1543
				MSA	1643
				G.M	
				CA	1480 (74)
				MSA	1504 (85)

*G.M: Grand Mean

Table (i): PP mean values of all speakers/styles

Spr	Style	Mean	Spr	Style	Mean
E1	CA	916	N1	CA	1048
	MSA	985		MSA	1102
E2	CA	1018	N2	CA	1229
	MSA	1061		MSA	1269
E3	CA	992	N3	CA	1023
	MSA	1133		MSA	1109
E4	CA	931	N4	CA	1134
	MSA	1038		MSA	1160
E5	CA	892	N5	CA	954
	MSA	970		MSA	953
E6	CA	965	N6	CA	1073
	MSA	1021		MSA	1036
	G.M		N7	CA	1029
	CA	952 (47)		MSA	1048
	MSA	1035 (59)			
			N8	CA	1020
				MSA	1027
			N9	CA	1033
				MSA	1193
				G.M	
				CA	1060 (79)
				MSA	985 (322)

of all speakers/styles

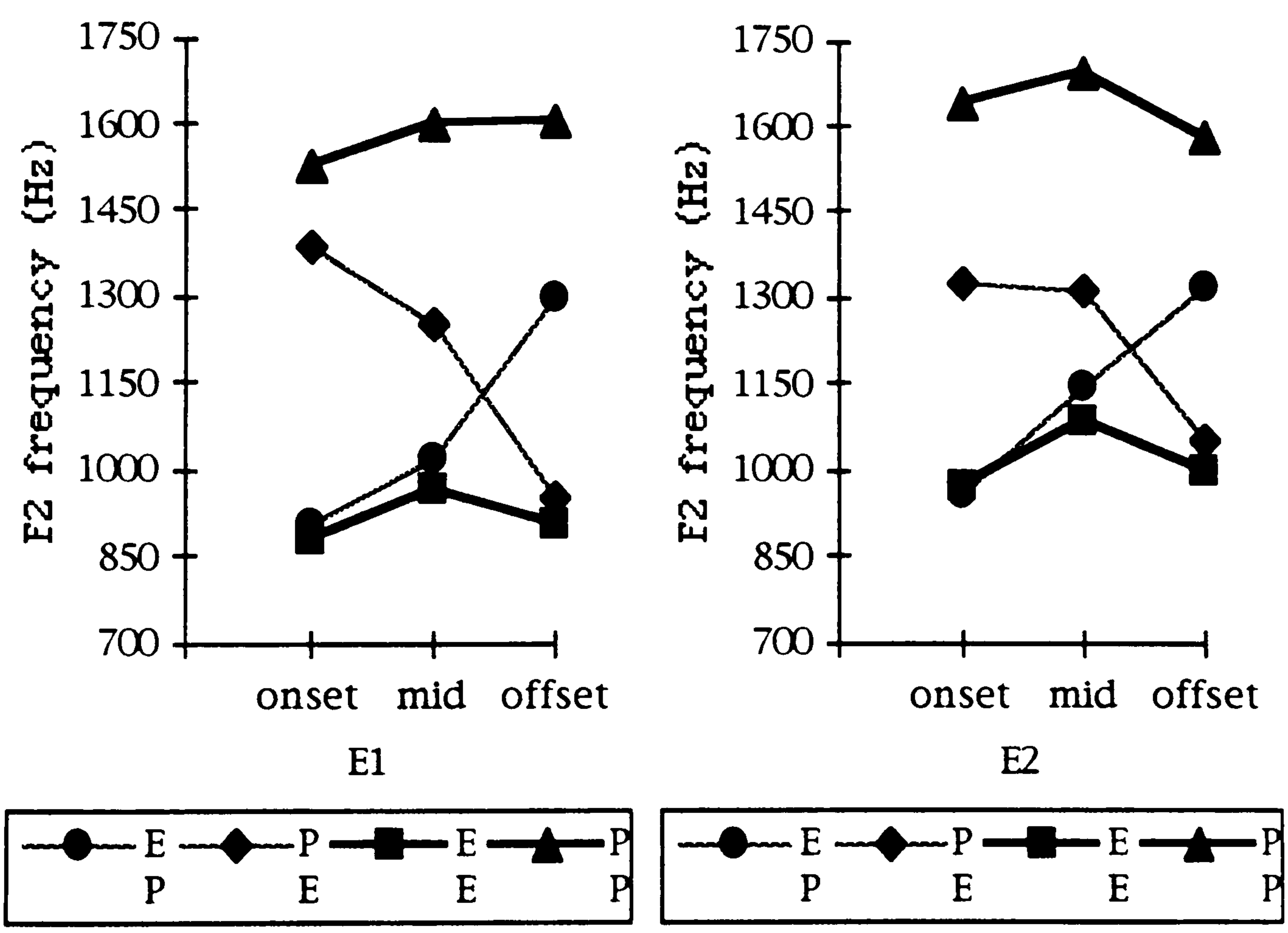
Spr	CA	MSA	Diff	Spr	CA	MSA	Diff
E1	398	306	88	N1	245	176	69
E2	363	233	130	N2	106	55	51
E3	264	107	157	N3	210	86	124
E4	485	360	125	N4	94	121	27
E5	333	264	69	N5	251	182	69
E6	398	436	+38	N6	363	297	66
				N7	366	271	95
				N8	269	219	50
				N9	375	176	181

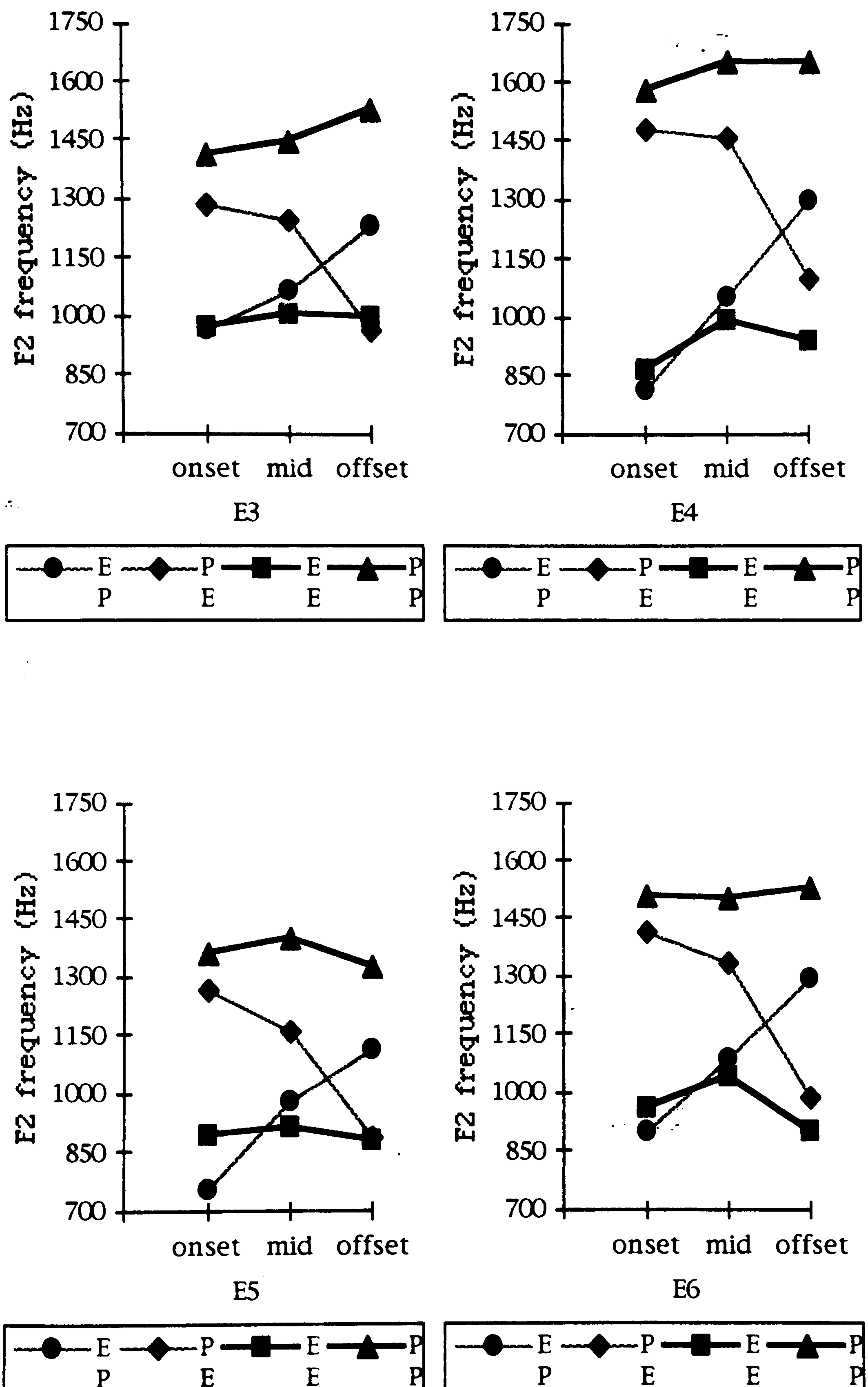
Table (iii): ΔF2 values of all speakers/styles (EP context)

Spr	CA	MSA	Diff	Spr	CA	MSA	Diff
E1	390	355	35	N1	188	141	47
E2	275	185	90	N2	41	38	3
E3	254	119	135	N3	123	21	102
E4	380	170	210	N4	98	87	11
E5	382	237	145	N5	233	45	188
E6	431	413	18	N6	409	177	232
				N7	357	229	128
				N8	301	73	228
				N9	287	99	188

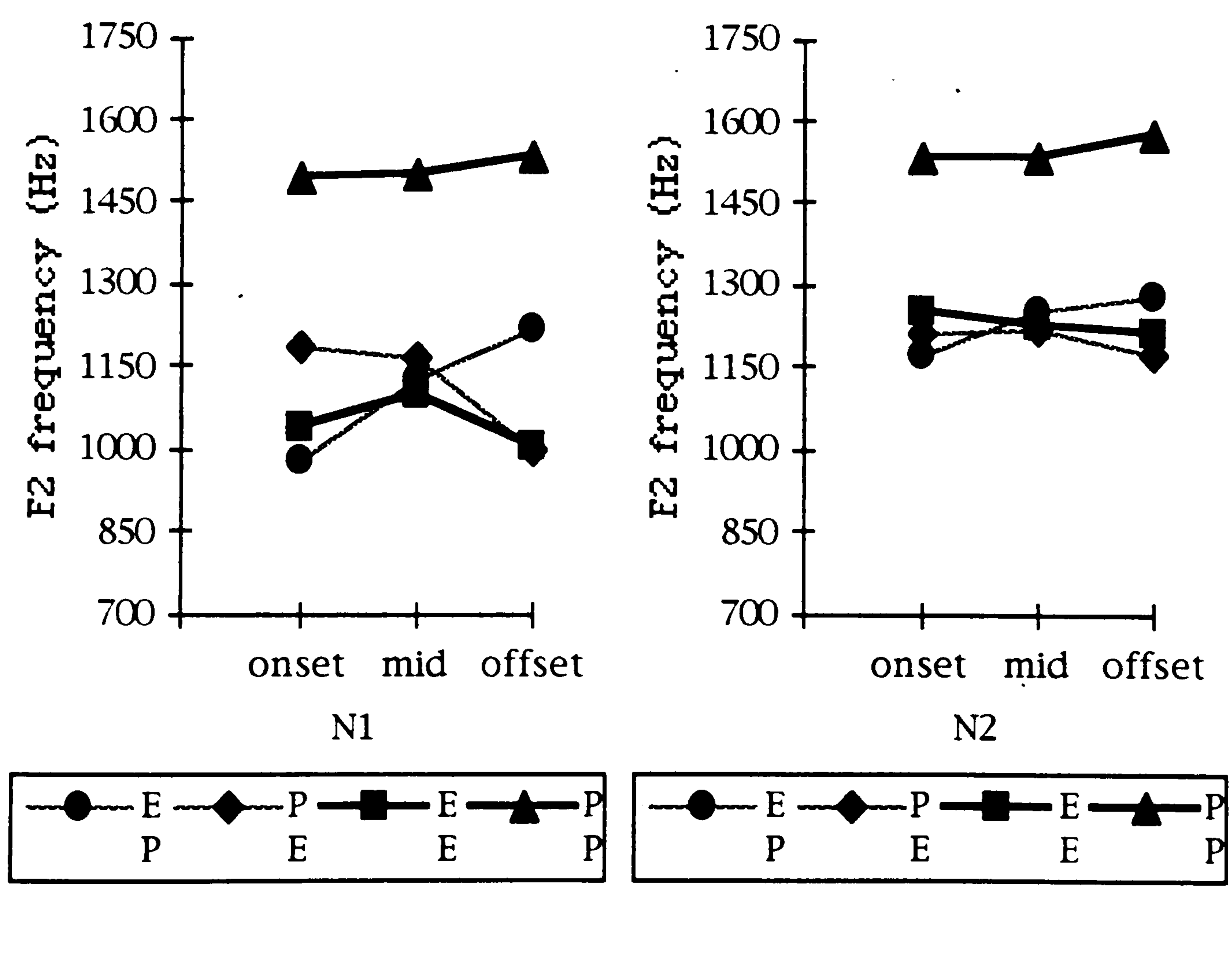
Table (iv): ΔF2 values of all speakers/styles (PE context)

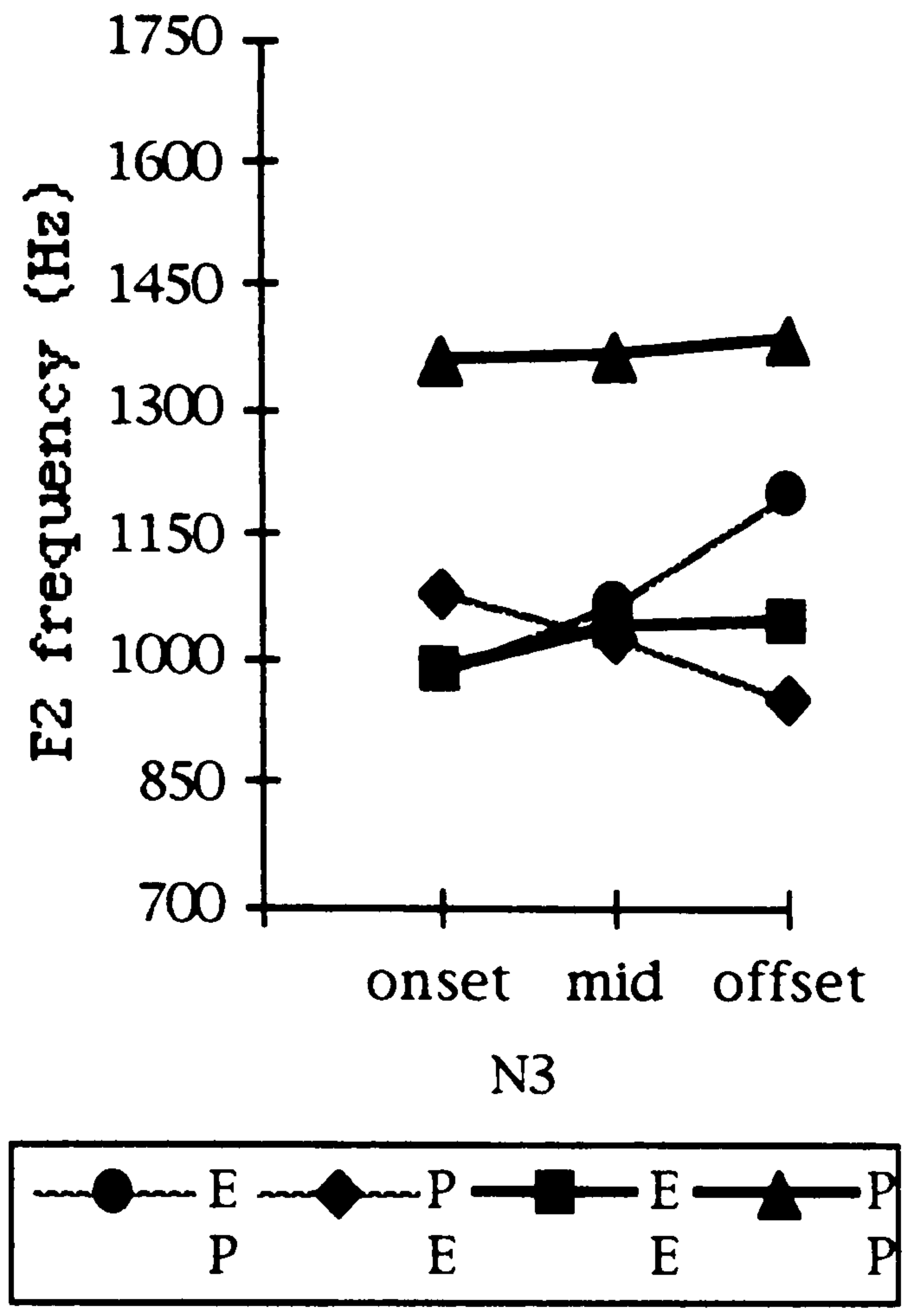
VOWEL TRAJECTORIES OF EXPERT RECITERS
ALL CONTEXTS
'RECITATION STYLE'

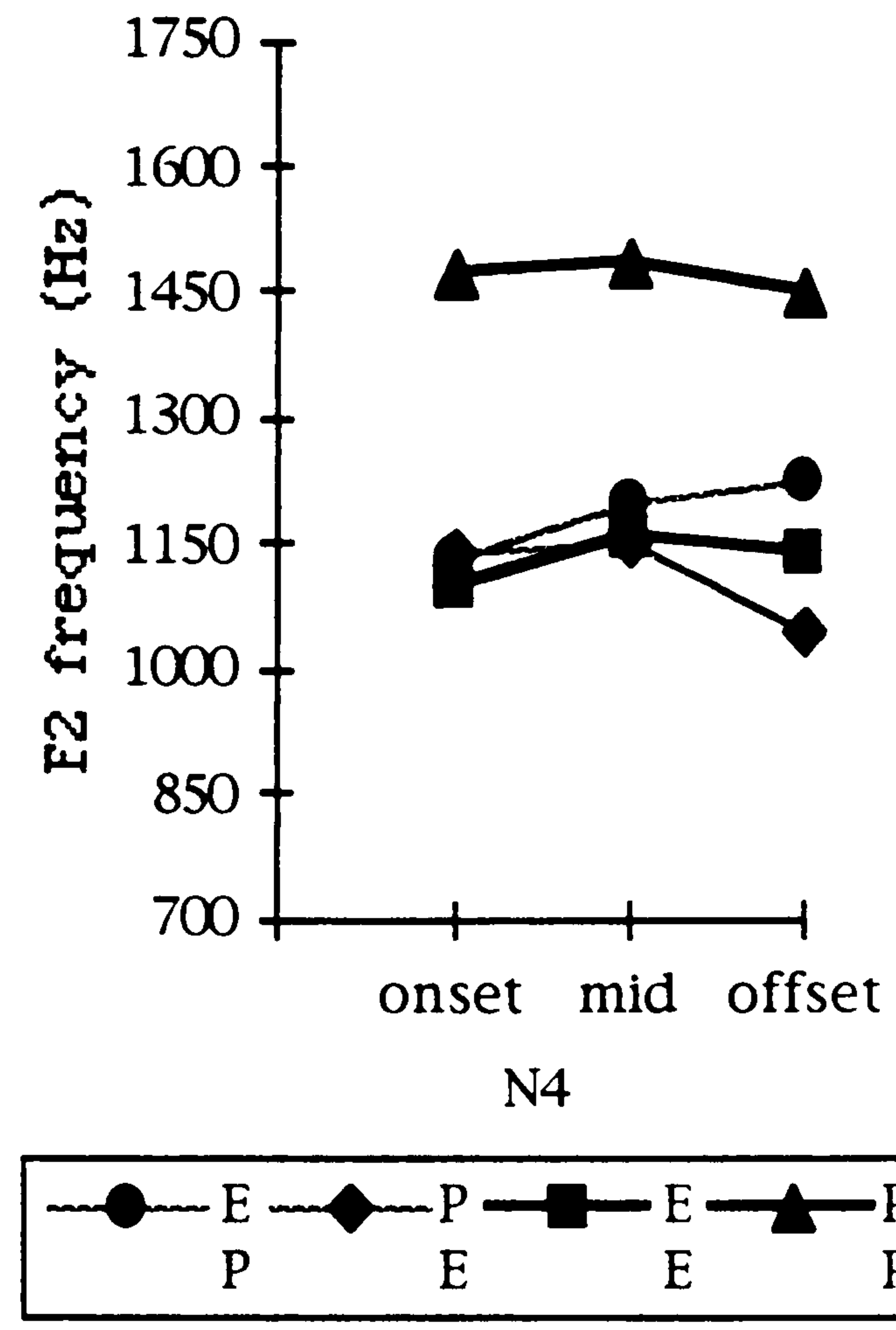


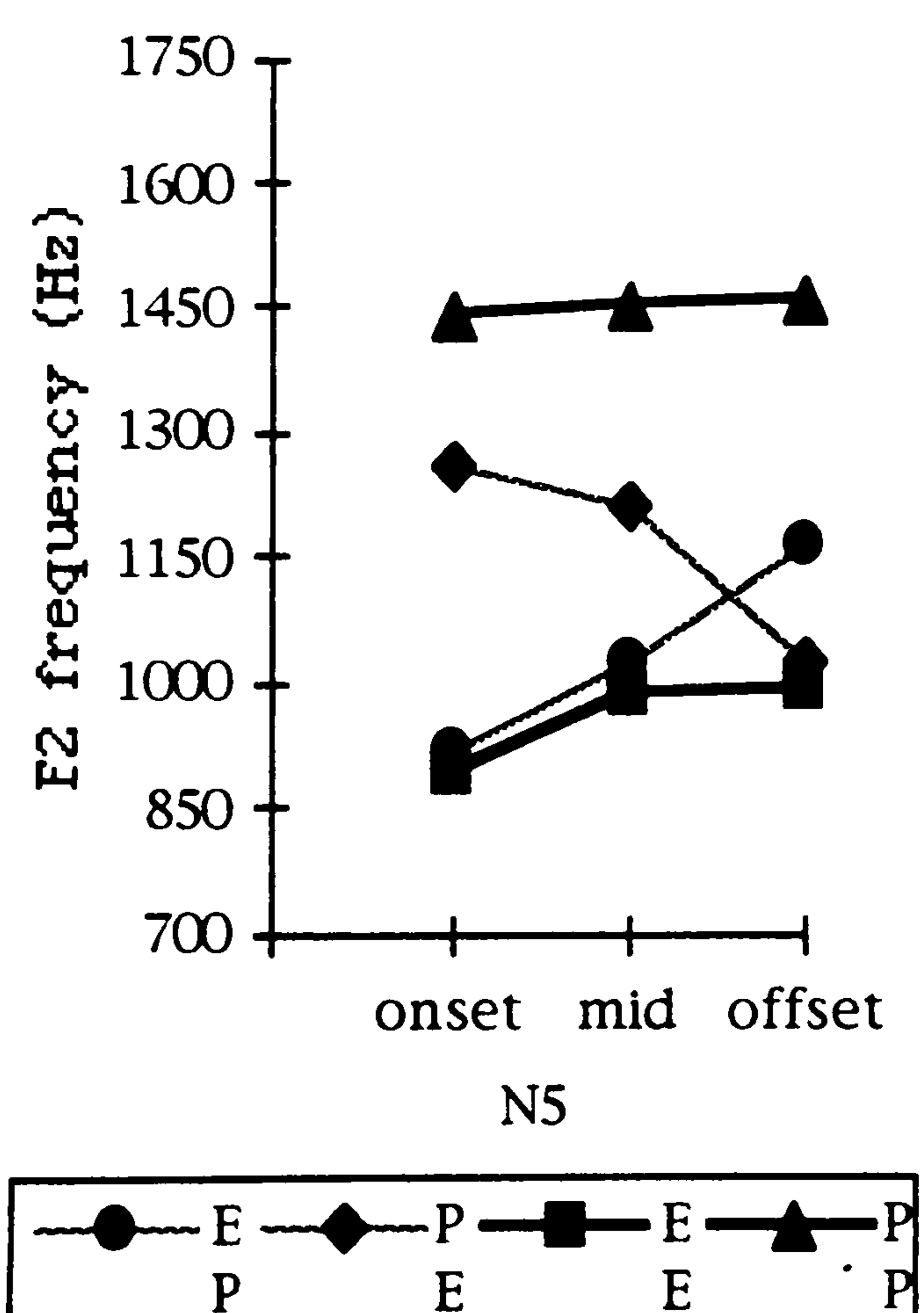

1750
1600
1450
1300
1150
1000
850
700
E2 frequency (Hz)
onset mid offset
E3
E P
P E
E E
P P
E4
E5
E6

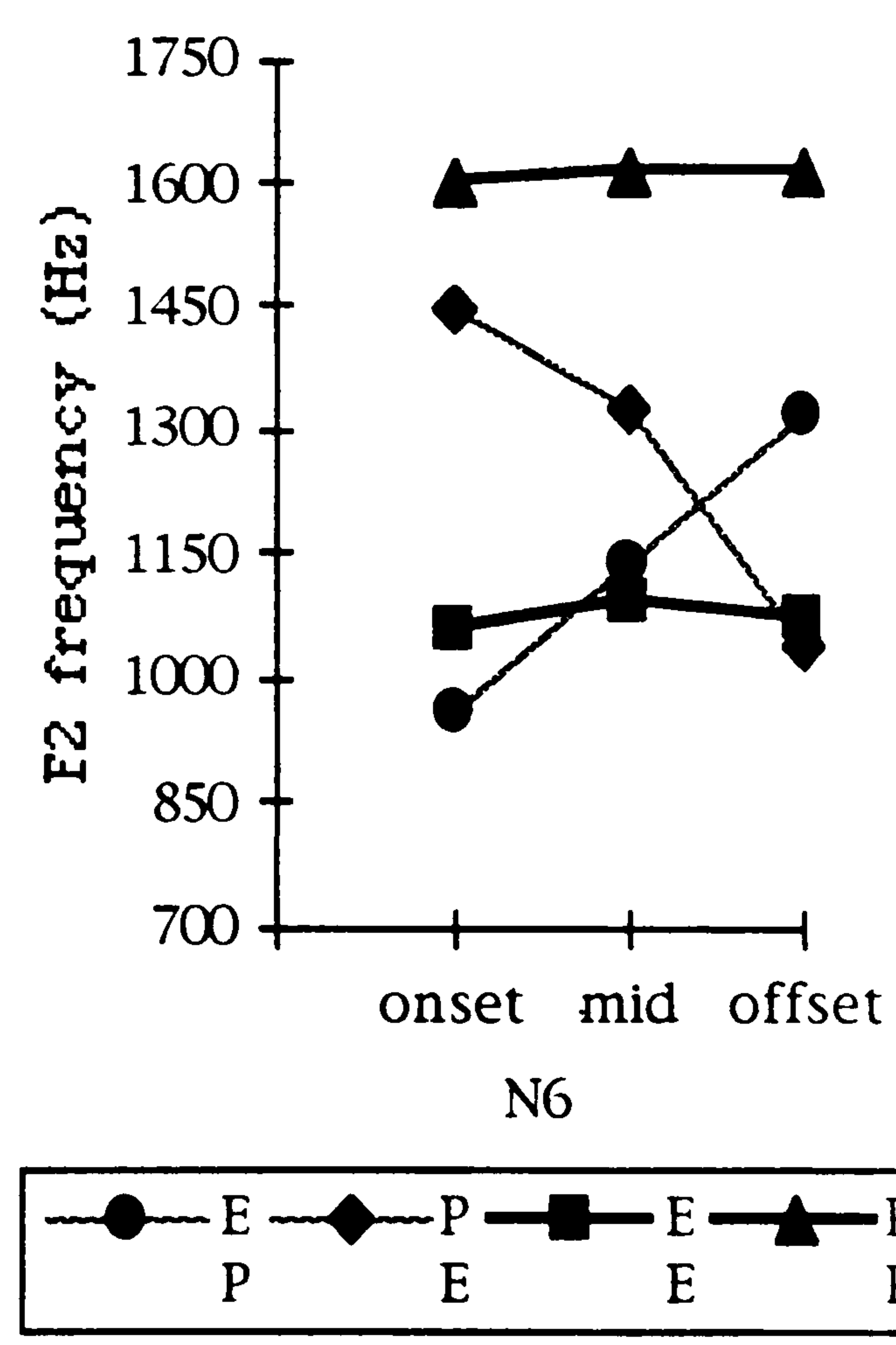
VOWEL TRAJECTORIES OF NON-EXPERT RECITERS
ALL CONTEXTS
'RECITATION STYLE'

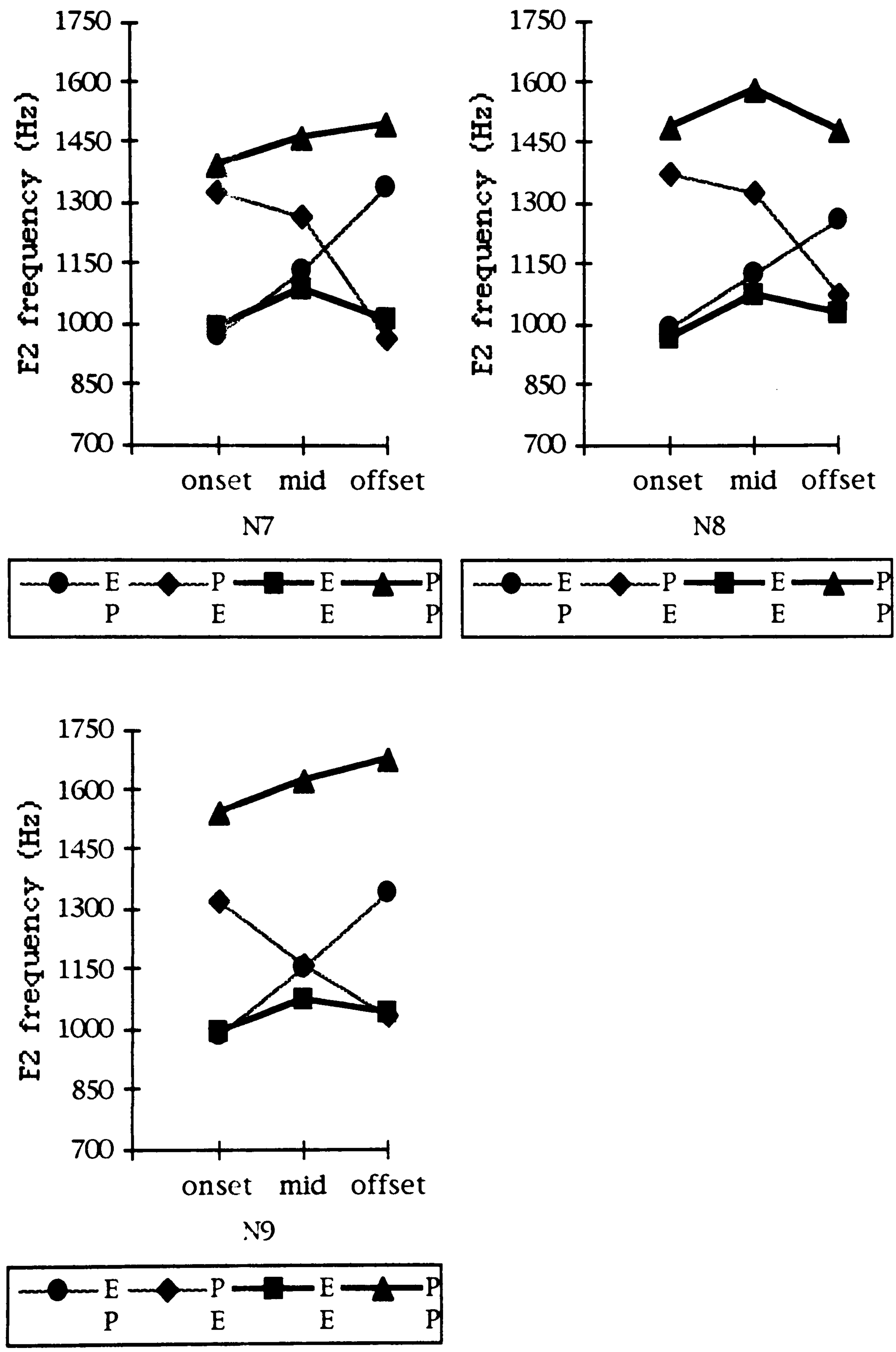



1750
1600
1450
1300
1150
1000
850
700
E2 frequency (Hz)
onset mid offset
N3
E P
P E
E E
P P


1750
1600
1450
1300
1150
1000
850
700
E2 frequency (Hz)
onset mid offset
N4
E P
P E
E E
P P


1750
1600
1450
1300
1150
1000
850
700
E2 frequency (Hz)
onset mid offset
N5
E P
P E
E E
P P


1750
1600
1450
1300
1150
1000
850
700
E2 frequency (Hz)
onset mid offset
N6
E P
P E
E E
P P


E2 frequency (Hz)
1750
1600
1450
1300
1150
1000
850
700
onset
mid
offset
N7
EP
PE
EE
PP
N8
N9

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HD: Historical Document (date unspecified).

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